Joint Ex. 1

(JCCX33 - Alan Manning, Monopsony in Motion (Princeton University Press, 2003))

PART 3

level of recruitment intensity, then recruitment activity will always be set at a level at which the labor supply constraint to the firm is just binding so there will be no involuntary unemployment. However, the model of vacancies as accidents introduced in the next chapter does go some way to alleviate this problem as that assumes that the labor supply to a firm is inherently stochastic making it impossible for the employer to fine tune its labor supply in this way.

9.6.3 *The Adverse Selection Model*

In the adverse selection model, due to Weiss (1980), the wage paid is assumed to affect the quality of workers. Cutting wages is assumed to cause the better workers to leave as they are assumed to have better outside options. Obviously this can only happen if the employer is unable (or unwilling) to pay different wages to workers of different quality. One problem for this model is to explain why this employer cannot observe worker quality but the outside options are better so that somebody else can.

In chapter 5 we argued that the empirical evidence suggests that employers do not seem to take account of all observable worker ability in setting wages. In the extreme, they pay a single wage to all workers and turn away workers who are thought not to be of sufficient quality. The higher the wage paid, the higher will be the average quality of workers in the firm. So, this does have the critical feature of the Weiss model. And the workers who are turned away will be experiencing involuntary unemployment because the employer is reluctant to cut wages to get them into employment.

9.6.4 *The Fairness Model*

Underlying all of the efficiency wage models discussed above is a reluctance on the part of employers to pay different wages to different types of workers. We argued in chapter 5 that there is reason to believe that this is the case. But, why employers seem to behave in this way is unclear. Akerlof and Yellen (1990) have suggested that workers are concerned with fairness. This might be fairness among workers, so that offering workers different wages will, if seen as unfair, reduce worker effort and morale so that output falls. Or it might be fairness between worker and employer, in that cutting wages for all workers has the same effect. These ideas have been used by Akerlof to explain involuntary unemployment: as we have seen, they implicitly underlie much of the discussion that has gone before.

9.6.5 Is Involuntary Unemployment a Useful Concept?

In this section we have argued that the concept of involuntary unemployment is perfectly compatible with the idea that employers have non-negligible market power. But, it has done nothing to show that involuntary unemployment exists or is a helpful concept. Perhaps the clearest evidence that involuntary unemployment exists comes not from looking at the process by which the unemployed get jobs, but from the process by which the employed lose them. The fact that many workers are unhappy when they lose jobs is indication that employers destroy jobs when there is still some surplus remaining to workers. This then also suggests that they would be reluctant to hire some workers (e.g., those just laid off) when there is some surplus to workers, the condition needed for involuntary unemployment. A formal analysis of the determinants of job destruction in an efficiency wage model is not developed here. It would not be difficult to do: one could take the Mortensen and Pissarides (1994) matching model of job destruction (in which jobs are only destroyed when the surplus is zero) and add some part of the shirking model.

Is the distinction between voluntary and involuntary unemployment a helpful one? To illustrate the circumstances in which it might be helpful, consider a policy that provides a subsidy to the employment of a small group of individuals, for example, the long-term unemployed as targeted in the US unemployment bonus experiments (for a review, see Meyer 1995) or the UK New Deal scheme. If wage setting is individualistic, it does not matter whether the subsidy is given to the employer or the worker as the wages paid can be adjusted accordingly to ensure that the net real wage received by the worker and paid by the employer are independent of who receives the subsidy. This is the well-known result in public finance that the economic incidence of a tax or subsidy is independent of the formal incidence.

But if wage setting is not individualistic (and we have argued that this is the case), then who receives the subsidy does matter. Consider the case where there is no impact of the scheme on the wages paid by employers to workers. If unemployment is all voluntary, then giving the subsidy to the employer will do nothing to increase employment and the subsidy should be given to the worker. However, if unemployment is involuntary, then it is the action of employers not workers that is the constraint on employment, and the subsidy will be more effective if given to employers. So, the theoretical distinction between voluntary and involuntary unemployment may have some practical benefit in the presence of wage rigidities. It should be noted that Meyer (1995) finds that giving the subsidy to the worker seems more effective than giving it to the employer although there is also the suspicion that this may be

because workers are reluctant to inform employers that they are eligible for the subsidy in the first place.

9.7 Conclusions

This chapter has considered the actions of workers in a labor market characterized by wage dispersion caused by the existence of frictions. The search approach to unemployment is a familiar one so this chapter has done little more than reinforce pre-existing ways of thinking about the determinants of unemployment.

This chapter has a number of substantive contributions. First, it has provided a coherent distinction between inactivity and unemployment based on the level of job search activity and provided evidence on how job search activity responds to variations in the overall state of the labor market (job search among the non-employed seems to be pro-cyclical). It has provided evidence (based on the determinants of reservation wages) that off-the-job search is more effective than on-the-job search. It has provided evidence that those in higher wage jobs are less likely to be looking for alternative employment, evidence that there is a wage dispersion in the labor market. It has suggested that quits to non-employment depend negatively on the level of wages because of the impact of shocks to the value of leisure. And, finally, the chapter has shown how one can reconcile search models of unemployment with ideas of involuntary unemployment.

This chapter has been about how the actions of workers can affect their employment opportunities. But, this is also influenced by the actions of employers: this is the subject of the next chapter.

Appendix 9

Proof of Proposition 9.1

The reservation wage, r, will satisfy $V(r) = V^u$. Evaluating (9.4) at $w = r$, and subtracting this from (9.2) leads to

$$r + (\lambda_e(r) - \lambda_u)\int_r [V(x) - V(r)]dF(x) - c_e(\lambda_e(r), z) = b - c_u(\lambda_u(r), z) \tag{9.11}$$

Now, differentiate (9.4) with respect to the wage to yield

$$\frac{\partial V(w)}{\partial w} = \frac{1}{\delta + \lambda_e(w)(1 - F(w))} \tag{9.12}$$

where $\delta = \delta_u + \delta_r$. In deriving (9.12) we have used the envelope condition for the choice of λ_e. Now integrate the term under the integral sign in (9.11) by parts to obtain

$$\int_r [V(x) - V(r)]dF(x) = \int_r \frac{\partial V(x)}{\partial x}[1 - F(x)]dx \qquad (9.13)$$

Substituting (9.12) into (9.13) and then putting it back into (9.11) yields (9.6). (9.6) uniquely defines the reservation wage as the left-hand side is strictly increasing in r.

Proof of Proposition 9.2

The value of being in a job or non-employed now depends on b so we write the value functions as $V^u(b)$ and $V(w, b)$. The decision rule for a worker with value of leisure b will, as before, be to accept any job where the wage is above the reservation wage $r(b)$ where $r(b)$ satisfies $V(r(b), b) = V^u(b)$. Let us define $\rho(w)$ to be the highest level of b consistent with being prepared to work in a firm paying a wage w, that is, we must have $r(\rho(w)) = w$. If the worker is in a job paying w and their value of b changes to be above $\rho(w)$, then they will quit. With this in mind, the value functions (9.2) and (9.4) need to be modified to

$$\delta_r V^u(b) = b + \lambda_u \int_{r(b)} [V(x, b) - V^u(b)]dF(x) + \kappa \int [V^u(\beta) - V^u(b)]dH(\beta) \qquad (9.14)$$

and

$$\delta_r V(w, b) = w - \delta_u[V(w, b) - V^u(b)] + \lambda_e \int_w [V(x, b) - V(w, b)]dF(x)$$
$$+\kappa \int^{\rho(w)} [V(w, \beta) - V(w, b)]dH(\beta) + \kappa \int_{\rho(w)} [V^u(\beta) - V(w, b)]dH(\beta) \qquad (9.15)$$

The reservation wage must satisfy $V(r(b), b) = V^u(b)$ which, using (9.14) and (9.15), can be written as

$$r(b) + (\lambda_e - \lambda_u) \int_{r(b)} [V(x, b) - V(r(b), b)]dF(x)$$
$$+ \kappa \int^b [V(r(b), \beta) - V^u(\beta)]dH(\beta) = b \qquad (9.16)$$

where we have used the fact that $\rho(r(b)) = b$. Integrating the integral terms in (9.16) by parts, can be written as

$$r(b) + (\lambda_e - \lambda_u) \int_{r(b)} \frac{\partial V(x,b)}{\partial x}[1 - F(x)]dx$$

$$- \kappa \int^b \left[\frac{\partial V(r(b),\beta)}{\partial \beta} - \frac{\partial V^u(\beta)}{\partial \beta} \right] H(\beta) d\beta = b \qquad (9.17)$$

Now differentiating (9.15) we have

$$[\delta + \lambda_e(1 - F(w)) + \kappa] \frac{\partial V(w,b)}{\partial w} = 1 + \kappa \int^{\rho(w)} \frac{\partial V(w,\beta)}{\partial w} dH(\beta) \qquad (9.18)$$

Note that the solution to (9.18) will be independent of b so that we obtain

$$\frac{\partial V(w,b)}{\partial w} = \frac{1}{\delta + \lambda_e(1 - F(w)) + \kappa(1 - H(\rho(w))} \qquad (9.19)$$

Now, differentiating (9.15) with respect to b we have

$$\delta_r \frac{\partial V(w,b)}{\partial b} = \delta_u \left(\frac{\partial V^u(b)}{\partial b} - \frac{\partial V(w,b)}{\partial b} \right) - \kappa \frac{\partial V(w,b)}{\partial b} \qquad (9.20)$$

where we have used the fact that $\partial^2 V(w,b)/\partial w \partial b = 0$ so that

$$\frac{\partial V(x,b)}{\partial b} = \frac{\partial V(w,b)}{\partial b}$$

Differentiating (9.14) with respect to b leads to

$$\delta_r \frac{\partial V^u(b)}{\partial b} = 1 - \lambda_u[1 - F(r(b))] \left(\frac{\partial V^u(b)}{\partial b} - \frac{\partial V(w,b)}{\partial b} \right) - \kappa \frac{\partial V^u(b)}{\partial b} \qquad (9.21)$$

Combining (9.20) and (9.21) leads to

$$\frac{\partial V^u(b)}{\partial b} - \frac{\partial V(w,b)}{\partial b} = \frac{1}{\delta + \lambda_u(1 - F(r(b))) + \kappa} \qquad (9.22)$$

Substituting (9.22) and (9.19) into (9.17) leads to (9.7). This proves part 2. Part 1 is proved simply by noting that the quit rate to non-employment is given by $\kappa[1 - H(\rho(w))]$ which is decreasing in the wage.

Proof of Proposition 9.3

If a worker with utility of b when unemployed (call them a b-worker) and a firm paying wage w are matched, employment will result if the worker wants the job and the firm wants the worker. Let us consider when this will be the case. Define $V(w,b)$ to be the value for a b-worker of being employed in a wage paying w when they do not shirk. Similarly define

$V^s(w, b)$ to be the value of the job when they do shirk. Similarly define $V^u(b)$ to be the value of being a b-worker when unemployed. It will turn out that a b-worker will get employment whenever w exceeds some threshold level $w(b)$ (which is derived below).[13] $w(b)$ is the minimum wage at which a b-worker will not shirk. Then

$$\delta_r V(w, b) = w - e + \lambda \int_{\max(w, w(b))} [V(x, b) - V(w, b)]dF(x) + \delta_u[V^u(b) - V(w, b)] \quad (9.23)$$

$$\delta_r V^u(b) = b + \lambda \int_{w(b)} [V(x, b) - V^u(b)]dF(x) \quad (9.24)$$

$$\delta_r V^s(w, b) = w - \theta[V^s(w, b) - V^u(b)] + \lambda \int_{\max(w, w(b))} [V(x, b) - V(w, b)]dF(x)dF(x) + \delta_u[V^u(b) - V(w, b)] \quad (9.25)$$

In these equations we consider what happens if a worker is employed at a wage below $w(b)$ in order to derive the no-shirking condition although, in equilibrium, this will never happen. As

$$\frac{dV(w, b)}{dw} = \frac{1}{\delta + \lambda[1 - F(\max(w, w(b)))]} > \frac{1}{\delta + \theta + \lambda[1 - F(\max(w, w(b)))]} = \frac{dV^s(w, b)}{dw} \quad (9.26)$$

$V(w, b) - V^s(w, b)$ is increasing in the wage so that the no-shirking condition will a be a cut-off rule of the form $w \geq w(b)$ where $V(w(b), b) = V^s(w(b), b)$. Using (9.23) and (9.25), this condition can be written as

$$V(w(b), b) = V^u(b) + \frac{e}{\theta} \quad (9.27)$$

(9.27) is an example of what is called a no-shirking condition as it says that the utility the worker gets from the job must be strictly larger than the utility available when unemployment to prevent shirking. As $\theta \rightarrow \infty$ and monitoring becomes perfect, the premium that needs to be paid to

[13] It is simple to prove that the equilibrium cut-off rule must be of this form (see (9.26)) but allowing for a general hiring rule at this stage introduces tedious additional notation which only complicates the presentation.

workers to prevent them from shirking goes to zero. However, we can provide a more convenient expression for $w(b)$.

Integrating the final term in (9.23) and (9.24) by parts, and using the first part of (9.26), we can derive

$$\delta_r V(w(b), b) = w(b) - e + \lambda \int_{w(b)} \frac{[1 - F(x)]}{\delta + \lambda[1 - F(x)]} dx + \delta_u [V^u(b) - V(w(b), b)] \quad (9.28)$$

$$\delta_r V^u(b) = b + \lambda[V(w(b), b) - V^u(b)][1 - F(w(b))] + \lambda \int_{w(b)} \frac{[1 - F(x)]}{\delta + \lambda[1 - F(x)]} dx \quad (9.29)$$

Combining (9.28) and (9.29) with (9.27) allows us to write the no-shirking condition as (9.8).

10

Vacancies and the Demand for Labor

THE previous chapter considered the role of workers' actions in influencing labor market transition rates and, hence, employment, unemployment, and inactivity rates. This chapter considers how the actions of employers affect the same variables. The main way in which firms can influence the arrival rate of job offers is by creating vacancies and spending resources in trying to fill them, and the main way in which they can influence the separation rate is by the lay-off decision.

Part of this chapter is concerned with the choice of recruitment intensity by firms. One way of thinking about this extra choice is that, for a given wage, variation in the recruitment intensity will determine employment in the firm. So, this chapter is the substitute for what in a more traditional labor economics textbook is the chapter on labor demand as that subject normally studies the amount of labor demanded by the firm for a given wage (although, in a competitive market, the firm has no control over the wage). There is an enormous amount of research that purports to provide estimates of "labor demand curves" (for a survey, see Hamermesh 1993). These labor demand curves are generally thought to estimate the relationship "marginal revenue product of labor equals the wage" so, on the face of it, they would seem to be inconsistent with a view of the labor market in which employment might be thought to be primarily supply-determined (as in the simple textbook model of monopsony) and wages are less than the marginal revenue product. But, it is simple to reconcile the apparent existence of labor demand curves with monopsony. For employers with some market power, one can write the first-order condition for employment as

$$Y'(N) = w(1 + \varepsilon) \tag{10.1}$$

where ε is the inverse of the elasticity of the labor supply curve facing the firm. (10.1) makes it apparent that anything that changes the wage but leaves ε unchanged (i.e., iso-elastic shifts the labor supply curve) will lower employment leading to an apparent labor demand curve. But, these labor demand curves will not be a good guide to the impact of policies like the minimum wage and equal pay legislation, which are likely to change ε as well as the wage.

There are other reasons why one might think it implausible that employment is primarily supply-determined. In the simplest models of monopsony (like the Burdett–Mortensen model of section 2.4), the matching process is modeled as one in which workers find it difficult to locate employers and get employment immediately they find a firm that pays them a wage above their reservation wage. Yet, when one thinks about the real world, finding employment often does not seem to be that easy. It is more helpful to think of the matching problem, not as a problem of finding an employer (one can simply look them up in the business pages of the phone book) but of finding vacancies. Associated with this view that it is hard to find employment, reported vacancy rates are generally very low, the number of applicants for jobs is quite large, and vacancy durations are often very short. Typically only a small proportion of firms report difficulties in hiring labor. These facts might seem to be inconsistent with the idea of a labor market that is monopsonistic and in which one thinks of employment as primarily determined by the supply of labor to the firm.

The second section of this chapter offers an interpretation of this conundrum and argues that the data on vacancy rates and durations are perfectly consistent with employers having non-negligible market power. The problem with the simplest models of monopsony is that there is no real notion of a vacancy (an unfilled job) within them. When one modifies the model to provide a well-defined notion of a vacancy, the monopsony model can explain the stylized facts about vacancy rates very well. We will argue that information on vacancy rates, etc. contains essentially no information about the extent of labor market power possessed by employers.

The basic argument can best be summarized by an analogy to oligopoly in the product market. Oligopolists want to sell more output at their price so that they have an "excess supply of output" in the same way as a monopsonist has an "excess demand for labor." But we do not expect oligopolists to produce the output they would like to sell but cannot. The absence of large stocks of unsold goods is not evidence that the product market is competitive. In the same way, monopsonists do not create jobs they would like to fill but do not expect to be able to. But, they find it difficult to exactly predict separations and recruits so that sometimes there is an unfilled job. These vacancies should be thought of as "accidents" rather than as an indicator of the general excess demand for labor.[1]

The fourth section of the chapter considers the process by which workers contact firms. In all the formal models of monopsony used so far, it

[1] The vacancy rate may be more useful as an indicator of the cyclical level of demand as, if firms do not vary wages much over the business cycle, the vacancy rate is likely to exhibit sharp swings.

has been assumed that workers contact firms at random. Burdett and Vishwanath (1988) term this random matching and consider an alternative matching technology in which the arrival rate of job applicants is proportional to the number of workers so that large firms have an intrinsic advantage over small firms in recruitment—what they term balanced matching. The conclusion will be that the empirical evidence does not suggest that random matching is particularly important.

Finally, section 10.5 presents evidence on the costs of recruitment for employers. In the generalized model of monopsony introduced in section 2.3, it was pointed out that an important question is whether employers face increasing marginal costs of recruitment with perfect competition the case where the marginal cost of recruitment is constant and "monopsony" the case where it is increasing in the level of employment. It is hard to get data on recruitment costs but some empirical evidence is presented in favor of the view that there are diseconomies of scale in recruitment.

10.1 The Interpretation of Vacancy Statistics

Perhaps the best source of information on the recruitment activities of firms are statistics on vacancies, although it should be noted that, even on this subject, there are relatively few papers. For example, only 15 out of 300 pages in the survey by Devine and Kiefer (1991) of the search approach to labor markets is concerned with the process of recruitment.

But, what studies there are seem to show a consistent picture. Studies from the United States (Holzer 1994), the United Kingdom (Beaumont 1978; Roper 1986, 1988) and the Netherlands (van Ours 1989; van Ours and Ridder 1992) all find that vacancy rates are low, that there are typically many applicants for vacancies, and that average vacancy durations are very short (particularly in comparison with the durations of spells of unemployment). Combined with the casual empiricism suggesting that workers have difficulty in finding jobs, one might conclude that firms could hire more workers at close to zero cost if they so desired and the fact that they appear to employ less workers than they could would suggest that the profit obtained from the marginal worker is zero. This picture of the labor market does not seem to be consistent with the simple monopsony model in which all firms always want more suitably qualified workers at a given wage as their marginal product exceeds the wage. Given this model, one might expect to see all employers engage in recruitment activities that are basically costless with signs outside their gates declaring "now hiring" and all firms would record permanent vacancies

with public employment services.[2] This simply does not seem an accurate description of the way in which labor markets work.

But, the problem is that the notion of a vacancy is not well defined in the models used until now. For example, the definition of a vacancy in British statistics is "a job which is currently vacant, available immediately and for which the firm has taken some specific recruiting action during the past four weeks."[3] In the standard models of monopsony, when asked about the number of vacancies, employers would not be able to give a meaningful answer. They would simply shrug their shoulders and explain that they had engaged in recruitment activity in the past four weeks but that there were an unlimited number of openings for suitably qualified workers.

The problem is that there is no notion of a "job" that can be filled or vacant, and without a notion of a "job" there can be no meaningful definition of a vacancy. It has been implicitly assumed that when a suitably qualified worker arrives at a firm, the employer can instantaneously endow him/her with the capital required for the job and has an immediate market for the output he/she will produce. There are some types of employment that are like this. For example, reading the situations vacant columns of London newspapers, one will generally see advertisements for minicab drivers. If one replies to these adverts, one typically finds that one can start work as soon as one has arranged appropriate insurance and if one has a suitable four-door car. In this job, the workers themselves provide the capital so that they can be put to work straight away. In this sector, it is probably true that there is no meaningful definition of a vacancy.

But most jobs are not like that. Typically, capital must be committed in advance of a worker being recruited: this might be in the form of an investment in machines or an investment in creating a market for the output. At any moment in time, there is then a well-defined number of jobs in each firm which may or may not be filled. Let us consider a modification of our basic model of monopsony that captures this feature of the world.

To keep matters simple, consider a model of a single firm. Assume that the decision for the firm is the wage that it pays, w, and the number of jobs, J. Assume that the cost of creating J jobs is cJ. Assume that output

[2] Mackay et al. (1971) do discuss the fact that, in the United Kingdom, a few firms used to have permanent vacancies recorded at employment exchanges, a practice that died out when unemployment rose but may now be reviving as labor markets tighten.

[3] Perhaps not surprisingly, different countries have different definitions of vacancies (for details, see Roper 1986). In the United States, a 600 page book was once devoted to *The Measurement and Interpretation of Vacancies* (NBER 1966) concluding, more or less, that the task was impossible. US measures of vacancies remain one of the few economic statistics measured in inches.

produced if employment is N is pN if $N \leq J$ and pJ for $N > J$.[4] Denote the number of workers who want to work for the firm at any moment in time by $N(w)$. Then steady-state expected profits will be given by

$$\pi = (p - w)E(\min(N(w), J)) - cJ \tag{10.2}$$

and (w, J) will be chosen to maximize (10.2).

The basic model of monopsony with its assumption of infinitesimal workers has one unfortunate implication for the analysis of vacancies. The law of large numbers implies that the labor supply to a firm is non-stochastic and is given by $N(w) = [R(w)/s(w)]$. Given w, it is then obviously optimal for the firm to set $J = N(w)$ and then to choose w to maximize

$$\pi = (p - c - w)N(w) \tag{10.3}$$

This obviously leads back to the standard model of monopsony.

What is the vacancy rate in this case? As all firms always have total employment equal to the number of jobs, the vacancy rate is zero. And vacancy durations are also zero as all workers who leave the firm are replaced immediately with probability one. So this seems approximately consistent with the real world in which vacancy rates and durations are very low, and vacancies are hard to find. But, on the other hand, every worker who contacts a firm in this model manages to get a job as they miraculously contact the firm at the instant that another worker is leaving. In some sense the number of applicants per job is one with probability one. And, the proportion of firms who have had a vacancy in any finite period of time, however short, is also one. These predictions do not sit comfortably with our perception of the way in which labor markets actually work.

The problem lies with the assumption that every individual worker is infinitesimal in relation to the size of the firm. To avoid this problem, assume that workers are of non-negligible size in relation to every firm. J and N must now be integers rather than any non-negative number.

The model we use is the following. At any moment in time, there is a stock of workers who would be prepared to work for the firm for a wage w and who the firm would be prepared to employ if they had an available job. Individual workers leave this pool of potential workers because, for example, they get a better job elsewhere, or because their personal circumstances change and a job in the firm is no longer attractive to them. Similarly, some other workers join the pool of potential workers.

[4] This assumes that both idle jobs and surplus workers produce no output. In reality the consequences of vacancies are more than just lost output. One might use the approach taken in Manning (1994a) to assume that production is most efficient when $N = J$ but that extra workers always produce some output.

So, at any point in time there will be a stock A of individuals who are interested in the job: we will call these potential workers. A will be a random variable: let us denote the steady-state probability that there are A potential workers by f_A. This density function is derived below.

Suppose that a firm has a vacancy so that $N < J$. For simplicity assume that the cost of posting a vacancy is zero as this seems a reasonable approximation to the cost of putting a sign on the gate of the firm or registering a vacancy with a public employment service. Assume that all the individuals in the applicant pool who do not already have employment in the firm see the vacancy immediately and apply for the job.[5] If there are one or more applicants, the vacancy will be filled immediately. If there are no applicants, then the firm is assumed to keep up the sign for the vacancy and wait for a suitable applicant to arrive.[6] The consequences of this are that employment will be the minimum of A and J, and that expected profits will be given by

$$\pi = (p - w) \sum_{A=0}^{\infty} \min(J, A) f_A - cJ \tag{10.4}$$

This is simply the equivalent of (10.2) and (w, J) will be chosen to maximize (10.4). To be able to make any progress, we need to say something about f_A.

To derive f_A, some assumptions about the rate at which individuals enter and leave the pool of potential workers are needed. Assume that if there are A potential workers in the pool, an extra individual joins at a rate $r_A(w, J)$. This arrival rate will depend on the wage because a higher wage makes a job in this firm more attractive, and possibly on J because this affects the level of employment which could conceivably affect recruitment rates. Similarly, assume that workers leave the pool at a rate $s_A(w, J)$. The possible dependence on w arises because the wage affects the desirability of jobs in this firm relative to other firms. The separation rate might depend on J because of differences in the effectiveness of employed and unemployed search. The simplest assumption is to assume that matching is random so that $r_A(w, J) = r(w)$ and that the rate at which people leave the pool of potential workers is independent of their status within it so that $s_A(w, J) = s(w)A$.

The problem described is analogous to well-known problems in queuing theory. One can think of A as being the stock of customers in the system at any moment in time. There are J counters dealing with the customers. If $A > J$, then there is a queue of customers and any counter

[5] This assumption is extreme but demonstrates that nothing depends on assuming that interested job applicants take time to see vacancies.

[6] This is essentially the stock-flow approach to matching suggested by Coles and Smith (1998), and used by Gregg and Petrongolo (1997) and Coles and Petrongolo (2002).

that becomes free will be occupied immediately. On the other hand, if $A < J$ there will be free counters. There is an enormous literature on the analysis of this sort of problem that can be drawn on to help us solve the problem (see, e.g., Gross and Harris 1974). A helpful result plus the special case of the basic model is provided in the following proposition.

Proposition 10.1. *The steady-state distribution of the number of potential workers is given by*

$$f_A = \frac{r_{A-1}r_{A-2}\cdots r_0}{s_A s_{A-1}\cdots s_1} f_0 \qquad (10.5)$$

where f_0 is the probability that there are no potential workers. f_0 is then solved by using the fact that the sum of the density function must be equal to one.

If $r_A(w, J) = r(w)$ and $s_A(w, J) = s(w)A$, A has a steady-state Poisson distribution which is given by

$$f_A = \frac{\exp(-N(w))N(w)^A}{A!} \qquad (10.6)$$

where $N(w) = r(w)/s(w)$.

Proof. See Appendix 10.

The notation $N(w)$ is used for the ratio of the flow of recruits to the separation rate as this is the supply of labor to the firm in the non-stochastic model. In the current model, it is the expected number of potential workers in the Poisson distribution (10.6). But, unlike the basic model there is some uncertainty about the actual number of potential workers: in fact, a feature of the Poisson distribution is that the variance is also given by $N(w)$.[7]

This framework reduces to the basic model of monopsony in two situations. First, if the set-up cost of a job c is zero, then there is no constraint on the number of jobs that a firm can create at no cost so it is obviously optimal to set $J = \infty$. Employment is then always the number of workers in the pool, the expected value of which is given by $N(w)$, that is, what we have used as steady-state employment in our basic models. In this case the only meaningful measure of a vacancy rate, $(J - E(N(w)))/J$, is one although, if the world was structured in this way, the concept of vacancy would probably never have occurred to anyone.

The other case in which this model reduces to the basic one is when we assume that workers are infinitesimal. Assume that each individual

[7] One can relax this; for example, it is well known that if there is some uncertainty about $N(w)$ then one can derive a negative binomial distribution for the number of applicants.

worker provides Δ of an efficiency unit of labor. Total employment of efficiency units of labor is then given by ΔN. We want to consider what happens as $\Delta \to 0$. As we consider this limit, we want to assume that the arrival rate of efficiency units of labor is the same so that we replace r by r/Δ. The expected number of workers is given by $N_\Delta(w) = r(w)/(s(w)\Delta)$. The expected number of efficiency units of labor in the pool is given by $E(\Delta N) = \Delta N_\Delta(w) = r(w)/s(w)$, that is, it is independent of Δ. But the variance of the number of efficiency units of labor in the pool is given by $\text{Var}(\Delta N) = \Delta^2 \text{Var}(N(w)) = \Delta^2 N_\Delta(w) = \Delta(r/s)$ which goes to zero as $\Delta \to 0$. Hence, the variance of the stock of potential workers goes to zero, that is, becomes non-stochastic. This then means it is optimal to have the firm set J equal to this level and the model then reduces to the simple model of (10.3) although vacancy rates are zero in this model.

So, for the analysis of vacancy rates to be interesting requires both that there is some set-up cost for a job and that an individual worker is non-negligible in relation to the size of the firm. Fortunately, neither of these assumptions is unreasonable.

The employer in this model wants to choose the wage, w, and the number of jobs, J, to maximize expected profits that are given by

$$\pi = (p - w)E(N) - cJ = (p - w)\sum_{A=0}^{\infty} \min(A, J) f_A - cJ \qquad (10.7)$$

This maximization problem is a bit awkward because the choice of J is restricted to the set of integers. This is rather inconvenient so we will, henceforth, approximate the Poisson distribution of (10.6) by assuming that A is normally distributed with mean $N(w)$ and variance $N(w)$, and that A can take any value. This is known to be a good approximation to the Poisson for values of $N(w)$ above 10 so that the error induced by doing this is likely to be small for firms of a reasonable size (one can verify this).

It is more convenient to model the choice variables for the firm not as (w, J) but as (w, X) where $X = [J - N(w)]/\sqrt{N(w)}$. Given that $N(w)$ is both the expected number of applicants and the variance in the number of applicants, $\Phi(X)$ is then the probability that $A \leq J$ and is therefore the probability of the firm having a vacancy. The first-order conditions for (w, X) are given in the following proposition.

Proposition 10.2. *The first-order conditions for (w, X) where $X = [J - N(w)]/\sqrt{N(w)}$ can be written as*

$$\Phi(X) = \frac{p - w - c}{p - w} \qquad (10.8)$$

and

$$\frac{(p-c-w)\left[\frac{1}{2}+\frac{1}{2}\frac{N(w)}{E(N)}\right]-\frac{1}{2}c\left[\frac{J-E(N)}{E(N)}\right]}{w}=\varepsilon \qquad (10.9)$$

where ε is the inverse of the elasticity of $N(w)$ with respect to w.

Proof. See Appendix 10.

As the left-hand side of (10.8) is the probability of a vacancy, this first-order condition can be interpreted as saying that a vacancy is more likely the lower is the wage and the lower is c relative to p. The intuition for this is straightforward. If the wage is low, profit-per-worker will be high so that the opportunity cost of having workers approaching the firm who cannot be employed because there are no jobs for them to do is high. This encourages the employers to create more jobs, raising the probability of a vacancy. And, the higher c is relative to $(p-w)$ the higher is the cost of having an unfilled job so that the employer will create few jobs.

(10.9) has some similarities to the usual first-order condition for the choice of the wage in monopsony. To see this, consider some special cases. For example, if $c=0$, it reduces to the familiar condition $(p-w)/w=\varepsilon$. And, if the variance in labor supply goes to zero and $E(N)\rightarrow N(w)$, then $J=E(N)$, and (10.9) becomes $(p-w-c)/w=\varepsilon$. This suggests that the important ideas of monopsony still hold in this model. That is not surprising because this model still has the feature that the supply of labor to the firm is not infinitely elastic. But, a more interesting question is whether this model is consistent with the statistics on vacancies referred to earlier.

Proposition 10.3. *Some statistics on vacancy rates are as follows.*

1. *The proportion of firms with a vacancy is*

$$\text{probability of a vacancy} = \Phi(X) \qquad (10.10)$$

2. *The average vacancy rate is given by*

$$\text{vacancy rate} = \frac{\sqrt{N(w)}[\phi(X)+X\Phi(X)]}{N(w)+\sqrt{N(w)}X} \qquad (10.11)$$

3. *The expected number of applicants for a vacancy is*

$$\text{expected number of applicants} = \frac{\sqrt{N(w)}[N(w)+\sqrt{N(w)}X][\phi(X)-X(1-\Phi(X))]}{N(w)-\sqrt{N(w)}[\phi(X)-X(1-\Phi(X))]} \qquad (10.12)$$

4. *The expected duration of a vacancy is given by*

expected vacancy duration

$$= \frac{\sqrt{N(w)}[N(w)[\phi(X) + X\Phi(X)] - \sqrt{N(w)}\Phi(X)]}{r(w)[N(w) - \sqrt{N(w)}[\phi(X) - X(1 - \Phi(X))]]} \qquad (10.13)$$

Proof. See Appendix 10.

While the equations, (10.10)–(10.13), provide the relevant information, they are not very informative. Accordingly, we present some simple simulations in table 10.1. With the exception of the vacancy duration, all the statistics in Proposition 10.3 depend only on $N(w)$ and X. The vacancy duration also depends on $r = sN(w)$ so that information on the separation rate can enable us to compute vacancy durations as well. We normalize p to be equal to $(1 + c)$ so that the net productivity of workers is independent of the ex ante cost of a job. We assume that the supply of labor to the firm has a constant elasticity equal to ε_{Nw} and that $N(w)$ is

TABLE 10.1
Simulated Vacancy Statistics

Cost of a Job, c	*Vacancy Rate (%)*	*Probability of a Vacancy*	*Expected Number of Applicants*	*Expected Vacancy Duration (Days)*	*Wage*
A. Elasticity of labor supply facing the firm = 4					
0.2	5.6	0.5	3	62.4	0.8
0.4	3.2	0.33	4.8	34	0.803
0.6	2.2	0.24	6.1	22.9	0.805
0.8	1.7	0.19	7.1	17	0.806
B. Elasticity of labor supply facing the firm = 8					
0.2	3.6	0.35	4.5	37.5	0.89
0.4	1.9	0.21	6.7	19	0.892
0.6	1.2	0.15	8.1	12.4	0.894
0.8	0.9	0.12	9.2	9.1	0.895

Notes.
1. These simulations are based on the additional assumptions that $p = (1 + c)$, that the annual separation rate is 25% and that the expected level of employment at the simple monopsony wage is equal to 50. The optimal solution is found by solving the first-order conditions in (10.8) and (10.9).
2. The vacancy rate is computed using the formula in (10.11), the probability of a vacancy using the formula in (10.10), the expected number of applicants using the formula in (10.12), and the expected vacancy duration using the formula in (10.13).

scaled such that, at the wage a simple monopsonist would choose, $(\varepsilon_{Nw}/(1+\varepsilon_{Nw}))$, the size of the firm is 50. Finally, we assume that 25% of workers leave the firm in the course of the year and then use this to compute a daily flow of recruits to the firm ($=r$).

Table 10.1 presents some statistics on vacancies and the wage chosen by the firm for different values of c, the set-up cost of a job and two values of ε_{Nw}, the elasticity of the labor supply curve facing the firm. By inspection of the final column in table 10.1, one can see that the wage chosen by the firm differs only very marginally from the optimal wage that a simple monopsonist would choose. The presence of ex ante set-up costs makes very little difference to the deviation between the marginal product and the wage.

However, these costs make an enormous difference to statistics on vacancies. If the set-up cost is low, for example, $c = 0.2$, one can see that if $\varepsilon_{Nw} = 4$, 50% of firms will have vacancies at any moment in time and 5.6% of jobs will not be filled. But if $c = 0.8$, only 19% of firms have vacancies and the vacancy rate will be 1.7%.

The extent of monopsony in the labor market does make a difference to the vacancy rate. The second half of table 10.1 presents vacancy statistics when the labor market is more competitive and $\varepsilon_{Nw} = 8$. The wage paid is now higher and, through (8.23) firms create fewer jobs. The vacancy rate if $c = 0.8$ is now only 0.9%. But, the important point is that vacancies can still be rare and vacancy durations short even in labor markets that have considerable monopsony power.

This very simple model does quite well in explaining the data. The US data used in Holzer (1994) and Holzer et al. (1991) has a vacancy rate of about 1.5%, suggesting that $c = 0.8$ if $\varepsilon_{Nw} = 4$. The model predicts that 19% of firms will have a vacancy, roughly consistent with the 12% estimated by Holzer (1994) for firms of that size. The predicted number of applicants for a job is 7, roughly consistent with the figures of 10 quoted by Holzer et al. (1991) particularly once one recognizes that the model here refers to the number of the applicants who are acceptable to the employer, while the figures in Holzer et al. (1991) also include workers who are not acceptable. And, finally the predicted vacancy duration is 17 days, compared with the 8 weeks reported in Holzer et al. (1991) (given that we have ignored the duration of the administrative procedure).

This section has shown how one can reproduce summary statistics about the incidence and duration of vacancies even in labor markets where employers have substantial market power. The reason why the observed vacancy rate has nothing to do with the extent of monopsony power is that the wage the firm pays is determined primarily by the elasticity of the expected supply of labor with respect to the wage.

Given the chosen wage, the number of jobs will be chosen to be approximately equal to the expected size of the labor pool. It will not be exactly equal: whether it is above or below $N(w)$ will depend on the job cost c. Vacancies are then "accidents," unavoidable but essentially random and conveying no useful information about the state of "labor demand" relative to "labor supply." Note, also that the fact that the majority of employers have no vacancy at a particular moment in time makes worker search for alternative jobs more difficult, contributing to the lack of competition in labor markets.

10.2 Filling Vacancies

This section investigates in more detail whether the empirical determinants of vacancies are consistent with the framework presented above. It uses data from a supplement to the 1990 UK Workplace Industrial Relations Survey (WIRS), the Employers' Manpower and Skills Practices Surveys (EMSPS). WIRS is a sample of slightly over 2000 workplaces that have more than 25 employees. It asks a wide range of questions about the personnel practices and other aspects of the workplace. The EMSPS is a supplementary survey completed by 1693 establishments designed to provide further information on recruitment, training, and turnover.

One of the questions asked in EMSPS is "how easily have you been able to fill vacancies in each occupational group in the last 12 months." Table 10.2 tabulates the responses for the nine occupational groups for which the question was asked. Employers report having most difficulty in filling vacancies in craft and skilled service occupations, and professional positions, and fewest problems in filling the least skilled manual jobs, and clerical and secretarial positions. In offering an explanation of this, we first need to offer an interpretation of the answers to the survey question. It seems most plausible to interpret the responses as being related to duration: vacancies are reported as hard-to-fill if the expected vacancy duration is long.[8]

One explanation for the occupational variation seen in table 10.2 is that employers are most likely to report problems with recruiting specialist workers because it is hard to cover for the lack of these

[8] If employers reported that they found it difficult to fill vacancies they were asked a subsequent question about whether this difficulty took the form of too few applicants or too low a quality. The responses were split approximately equally. This is consistent with our interpretation if one recognizes that applicants differ in quality and an employer also has a decision about a minimum acceptable quality of employee. See also Green et al. (1998) for a discussion of how this question relates to ideas of "skill shortages."

TABLE 10.2
The Difficulty of Filling Vacancies: UK EMSPS

	How Easily Have You Been Able to Fill Vacancies in Each of the Occupational Groups in the Last 12 Months? (Percent)					
	1 *very easily*	2	3	4	5 *very difficult*	*Number of Observations*
Routine, unskilled	32.2	41.9	10	11.6	4.3	768
Operative + assembly	32.9	40.9	11.8	10.6	3.7	550
Sales	20.2	33.6	18.3	24	3.9	432
Personal + protective services	24	42.2	15.1	13.7	5.1	396
Craft and skilled services	16.5	27.7	17.8	22.1	15.9	646
Clerical and secretarial	26.1	42.1	18.6	10.4	2.8	1061
Professional, associate, and technical	15.3	26.9	24	24.1	9.8	642
Professional	12.8	27.7	22.9	20.8	15.8	644
Management and administration	18.3	38.3	15.5	21.1	6.8	814

Notes.
1. All responses are weighted.

workers when there is a vacancy. Hence, forgone output is likely to be high when there is a vacancy in these jobs. On the other hand, vacancies in jobs that require general skills cause less of a problem because other workers in the firm can adjust their work patterns to mitigate the costs of the vacancy.

We might also be interested in the type of establishments that report recruitment difficulties within a given occupation. The main prediction of the monopsony model is that, other things being equal, we would expect a higher wage to be associated with fewer problems in recruitment. This is for two reasons. First, a higher wage leads to a lower level of job creation (see (10.8)) and, hence, a lower level of vacancies in higher-wage firms. Then, when vacancies do occur, there is more likely to be a suitable initial applicant and, hence, a higher chance of the vacancy being filled immediately. Second, the flow of recruits is likely to be higher so that vacancies are likely to be filled quicker even if there is no suitable initial applicant.

Table 10.3 presents some ordered probit models for the responses to the question on recruitment difficulties tabulated in table 10.2 for four occupational groups: the unskilled, operatives, the skilled, and clerical/secretarial.[9] The first column for each occupational group shows that recruitment difficulties are less likely in high-wage firms. The second column then includes some information on the extent of the recruitment activity of the firm by including the log of employment in the relevant occupation in the establishment, the recruitment rate (defined as the number of recruits, both internal and external, as a fraction of employment in the previous year), and the fraction of recruits to that occupational group that are internal. There is strong evidence that recruitment difficulties are less in higher-wage firms. There is also strong evidence that recruitment is easier in labor markets with high unemployment rates for the unskilled and the skilled, and that recruitment difficulties are greater when the recruitment rate is higher. This last result could be because, in a steady state, the recruitment rate is the separation rate and a high separation rate indicates that a job in the establishment is not very attractive. Alternatively, it may be that a high recruitment rate places greater strains on resources within the establishment.

This section has shown that, except for specialized positions, few firms report difficulties in filling vacancies. But, as the previous section has emphasized, this implies little about the extent of monopsony in the labor market. The evidence that, within occupations, high-wage firms do have fewer recruitment difficulties is consistent with the monopsony model.

[9] Not all the groups reported in table 10.2 are included because the wage information in WIRS is not recorded for the same occupations as the recruitment information.

TABLE 10.3
The Determinants of the Difficulty in Filling Vacancies

Occupation	*Routine Unskilled*		*Operative and Assembly*		*Craft and Skilled Service*		*Clerical and Secretarial*	
	1	*2*	*1*	*2*	*1*	*2*	*1*	*2*
ln(hourly wage)	−0.47	−0.39	−0.68	−0.46	−1.32	−1.39	−0.31	−0.42
	(0.17)	(0.19)	(0.25)	(0.29)	(0.40)	(0.52)	(0.16)	(0.18)
ln(employment)		0.002		0.022		−0.028		0.167
		(0.051)		(0.065)		(0.104)		(0.047)
Recruitment rate		0.699		0.665		0.414		1.44
		(0.169)		(0.218)		(0.624)		(0.251)
Proportion of internal recruits		0.711		0.306		−0.286		0.632
		(0.287)		(0.254)		(0.405)		(0.158)
Proportion female	0.047	0.143	0.133	0.114	−0.804	−1.28	0.726	0.843
	(0.175)	(0.197)	(0.219)	(0.248)	(0.389)	(0.54)	(0.230)	(0.258)
Local unemployment rate	−0.166	−0.142	0.036	0.082	−0.119	−0.169	−0.020	−0.009
	(0.029)	(0.033)	(0.037)	(0.043)	(0.049)	(0.064)	(0.022)	(0.025)
Number of observations	532	421	364	302	202	142	846	710
Pseudo-R^2	0.075	0.095	0.071	0.084	0.142	0.178	0.034	0.06

Notes.
1. The dependent variable is the response to the question described in table 10.2. A higher value indicates greater difficulty in filling vacancies. The estimation method is an ordered probit.
2. The recruitment rate is the number of recruits (both internal and external) into that occupation in the previous 12 months. The proportion of internal recruits is the fraction of those recruits who came from elsewhere in the firm.
3. All observations are weighted.

10.3 The Technology of Matching: Random versus Balanced Matching

Previous discussion has assumed that workers are equally likely to contact any employer, large or small, that is, we have what Burdett and Vishwanath (1988) term random matching. They suggest the alternative of "balanced matching" where the probability of contacting an employer is proportional to employment in the firm.[10] There are plausible reasons for thinking that not all matching may be random. For example, a common search method is to ask friends and family about job openings: this method is likely to sample firms in proportion to their employment, leading to balanced matching. One might wonder why this matters but, as shown below, the relative importance of balanced and random matching is important in determining the amount of long-run monopsony power that employers possess.[11]

Consider the following simple way of combining both balanced and random matching in the same model (this draws heavily on the set-up in Mortensen and Vishwanath 1994). Assume that the flow of recruits to the firm is given by

$$R(N, w) = [\alpha + (1 - \alpha)N]R(w) \qquad (10.14)$$

If $\alpha = 1$ this reduces to the random matching model in which the flow of recruits depends only on the wage and not on employment, while if $\alpha = 1$ we have pure balanced matching and the flow of recruits is proportional

[10] Burdett and Vishwanath (1988) criticize the assumption of random matching on the grounds that "an unfortunate consequence of random matching is that a firm, by splitting itself in two, can increase its number of potential employees ... and, thus, possibly increase its profits." (p. 1050). One must be careful about accepting this criticism of random matching as its validity depends on what exactly a firm is thought to be. One should probably think of firms as being located in some space, their position defined by their geographical location and by the type of jobs that they offer. Although we have set up the model as being one in which all firms are attractive to all workers, one could easily modify the model to an isomorphic one in which only a certain proportion of workers are interested in working for a particular firm whatever the wage. In this case, a firm cannot simply divide itself and double the number of applicants. It would need to locate elsewhere in the product space. In our basic model where we assumed that the number of firms is fixed, we effectively assumed that it is infinitely costly to set up a new firm: in this case, one cannot even conceive of a firm dividing itself. That is obviously too extreme but, in the free entry model of section 3.1, firms in equilibrium are simply making a level of profits equal to the set-up cost. In this case, the firm cannot divide itself without also doubling its fixed costs so that total profit will be unchanged.

[11] Note that the discussion here is about whether large employers have an intrinsic advantage over small firms in recruitment. This is not the same as the question of whether large firms choose to spend more resources on recruitment: the model of section 3.2 discussed this issue.

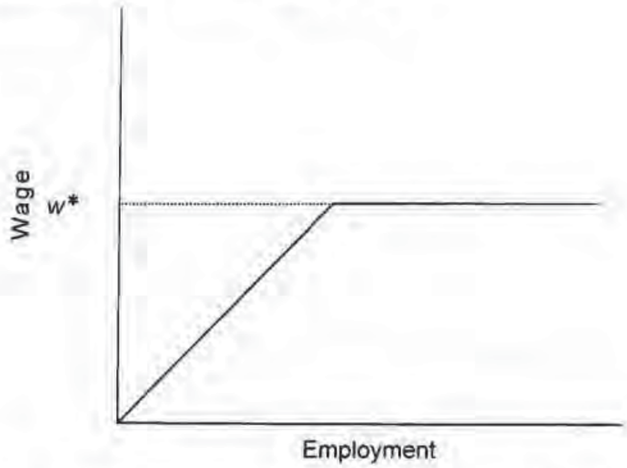

Figure 10.1 The long-run supply of labor to the firm with balanced and random matching.

to employment. Hence, α can be thought of as a measure of the relative importance of random matching. In a steady state, we must have $s(w)N = R(N, w)$ which, using (10.14) can be written as

$$s(w)N = [\alpha + (1-\alpha)N]R(w) \tag{10.15}$$

If all matching is random ($\alpha = 1$), this leads to the familiar upward-sloping labor supply curve. However, if all matching is balanced ($\alpha = 0$), matters are very different. If the wage is such that $s(w) > R(w)$ then the firm will, in the long-run, see its employment decline to zero. Alternatively if the wage is such that $s(w) < R(w)$ employment can (if the firm so wishes) grow without limit. What this means is that the long-run supply of labor to the firm is perfectly elastic at the wage where $s(w) = R(w)$, that is, the labor supply curve to an individual firm is effectively the competitive one.

For the intermediate case where $0 < \alpha < 1$ the labor supply curve will resemble that drawn in Figure 10.1 where w^* solves $s(w^*) = (1-\alpha)R(w^*)$.[12] It can readily be seen that the labor supply curve to an individual firm has a monopsonistic part and a competitive part. The lower is α, the more important is the competitive part of the labor supply schedule.

The conclusion that labor markets will be less monopsonistic the more important is balanced matching in the recruitment process can be found in the general equilibrium models analyzed by Burdett and Vishwanath

[12] Note that there may be no wage at which this equality can be satisfied.

(1988) and Mortensen and Vishwanath (1994). Both of these papers show that equilibrium is the perfectly competitive equilibrium if there is only balanced matching.

Given that the extent of monopsony in labor markets is related to the importance of balanced matching, the next section considers some empirical evidence on the matter.

10.4 Empirical Evidence on Random and Balanced Matching

To investigate the importance of balanced matching, one might think of taking a direct approach and investigating whether the flow of recruits is higher in larger firms, that is, to try to estimate (10.14) directly. However, this is not likely to be a fruitful approach as there is a serious problem of reverse causality in the estimation of (10.14) as employment will be higher in firms with a high level of recruits. To work, this approach would need to use as an instrument a variable that affects the separation rate (as this affects employment) but does not affect the flow of recruits directly: it is hard to imagine what such a variable might be.

Instead of using the absolute flow of recruits to estimate the importance of balanced matching, one could use the relative flow of recruits through random and balanced methods. We have

$$\text{probability of recruit through balanced matching} = \frac{\frac{1-\alpha}{\alpha}N}{1+\frac{1-\alpha}{\alpha}N} \tag{10.16}$$

so that how this probability varies with N can be thought to give some estimate of α. If we could identify which recruits came from balanced matching and which from random, it would be a simple matter to determine the relative importance of balanced matching. Of course, the relevant data are not available but we do have information on the search methods used by job-seekers and those recruited into jobs. Some search methods are more plausibly thought of as leading to random matching and some to balanced matching. For example, large firms have little advantage over small firms in the use of the public employment service while large firms have an advantage in the use of existing workers to inform their friends and relatives of job opportunities (this is the motivation for balanced matching given in Mortensen and Vishwanath 1994). Of course, there is likely to be some element of guesswork in deciding whether a particular search method is associated with random or

TABLE 10.4
Number of Search Methods

Number of Search Methods	*US (CPS)*	*UK (LFS)*	
	Unemployed (%)	*Unemployed (%)*	*Employed (%)*
1	33.2	7.3	16.5
2	53.9	9.5	19.1
3	8.2	14	18.6
4	3.1	16.2	18.7
5	1.6	17.8	14.4
6	0	17.9	8.4
7	–	11.5	3.3
>8	–	5.8	1
Mean (standard deviation)	1.86 (0.81)	4.58 (1.96)	3.39 (1.74)
Number of observations	47169	60416	59104

Notes.
1. Data from the CPS are from the period 1/97–12/98 and from the LFS for 12/96–11/98.

balanced matching but we can test our guesses by seeing whether large firms recruit more frequently through balanced methods.

The US CPS asks unemployed job-seekers to list up to six search methods that they have used in the previous four weeks. The UK LFS allows the unemployed to list up to eleven methods[13] and also asks the same question of employed job-seekers. In addition, they are asked to name their most important search method. Table 10.4 starts to analyze these answers by tabulating the number of search methods recorded on average. In the United States, the average number of search methods reported by the unemployed is 1.9 while it is 4.6 in the United Kingdom. Employed job-seekers in the United Kingdom report using rather fewer search methods—the mean is 3.4. There are a number of possible explanations for why the unemployed in the United Kingdom report more search methods than those in the United States. One is that they are given the option to list more. Although no-one takes the opportunity to list the maximum allowed, there is a considerable amount of overlap in some of the methods listed which may lead to multiple recording of what is essentially the same activity. For example, the UK LFS lists separately "answer advertisements in newspapers," "study situations vacant in newspapers," and "wait for the results of an application."

[13] Actually 14, if the three search methods specific to those seeking self-employment are included.

TABLE 10.5
Methods of Looking for Work

	US (CPS) method mentioned	*UK (LFS) method mentioned*		*UK (LFS) Most Important Method*	
	Unemployed	*Unemployed*	*Employed*	*Unemployed*	*Employed*
Contacted public employment service or other public body	22.4	74.9	23	28.7	6.6
Applied directly to employers	64	56.9	43.1	2.9	7.4
Placed or answered advertisements	14.3	64.4	53.9	9.9	13.4
Sent out resumes/applications	40	49.3	44.5	8.8	2.3
Looked at advertisements	19.6	91.2	87.2	35.3	49.6
Contacted friends/ relatives/unions	14.9	66.5	47.1	2.9	9.1
Private employment agency	5.6	23.9	23.9	10.3	7
Other	4	8.9	9.3	1.2	2.3
Number of observations	47169	60416	59104	60100	58650

Notes.
1. Data from the CPS are from the period 1/97–12/98 and from the LFS for 12/96–11/98.
2. The classification of search methods is different in the two countries and some re-classification has been done.

Table 10.5 summarizes the data on the search methods mentioned. The listing of search methods is not exactly the same in the two countries and this table reflects some judgments as to the equivalence of particular answers. As job-seekers in the United Kingdom report using more methods than those in the United States it is dangerous to compare the US and UK numbers too literally. But several factors stand out. First, use of the public employment service (PES) is much more widespread in the United Kingdom than the United States. There is little surprise here as the US PES has a reputation for attracting only low-quality workers and jobs. The same is true of the United Kingdom (note that the employed are much less likely to use the PES than the unemployed) but to a lesser extent.[14] But the unemployed in the United Kingdom also seem more likely to use private employment agencies and friends and/or relatives. In contrast, direct approaches to employers seem to be more prevalent in the United States. The final two columns examine the most important search methods as reported by UK job-seekers. Newspapers are the most important search method for both the unemployed and the employed although the PES is also important for the unemployed.

Which search methods should be classified as balanced matching and which as random? As the PES is free to employers, large firms are likely to have no advantage over small firms in its use. One might think the same is true of the use of private employment agencies and newspaper advertisements as the cost of using these is the same for small and large firms (although there may be cost advantages to large firms if they can advertise multiple vacancies). For these search methods, it is natural to assume that, for a given intensity of recruitment, the flow of job applicants will depend only on the wage and not on employer size, that is, we have random matching.

On the other hand, it is plausible to believe that large employers have an advantage over small employers when recruitment is through the friends and relatives of its current workforce as it is plausible to believe that the number of recruits forthcoming through this method will be increasing with the size of the firm.

For direct approach by workers to employers, it is unclear whether it is better to model this matching process as random or balanced. It depends on whether the search of workers is completely random or directed in some way and, if directed, the method of sampling used. It seems plausible to think that workers are more likely to approach the local sweet factory about work than the local sweet shop so that workers disproportionately approach larger employers: in this case, balanced matching would be more important than random matching.

[14] There is probably a vicious circle here. The lower the quality of jobs available through the PES, the less likely are "good" workers to use it, which then discourages firms from trying to fill good jobs through it.

TABLE 10.6
How Workers Get Jobs: UK LFS

	Total	*Number of Employees*				
		1–10	11–19	20–24	25–49	50+
Replying to a job ad	26.8	24.0	26.3	28.4	28.5	28.0
Public employment service	11.6	11.8	13.3	13.7	11.9	10.7
Private employment agency	8.3	3.7	4.3	5.6	7.5	12.5
Hearing from employee	28.7	33.0	30.9	28.1	28.8	25.5
Direct application	13.4	11.7	13.9	14.3	13.3	14.3
Other	11.2	15.7	11.2	9.9	9.9	9.0
Number of observations	66693	18320	7103	3360	8275	29635

Notes.
1. These data are the responses to the question of how current job was obtained asked in the UK LFS of those with less than three months of job tenure. Data come from the period 12/92–11/97. Public employment service includes the responses "jobcentre", "careers office" and "jobclub" (the last two categories are small).

The UK LFS also has information on the method by which new employees were recruited. Table 10.6 tabulates this information against employer size. As can be seen from the first column, "heard through employee" is the largest single category accounting for the method that 28% of new employees used to find their job. We might expect the importance of this method to give an advantage to large firms in recruitment. However, as the subsequent columns show, the proportion of hires through this method is actually smaller in large firms which is not what we would expect from (10.16) if balanced matching was important.

Of course, it is possible that these results come from a failure to control adequately for other factors. So, table 10.7 estimates a multinomial logit model for the method of recruitment. The omitted category is the "heard through employee." But, controlling for other factors does not make very much difference. New recruits in large firms are more likely to have been recruited through channels other than "word-of-mouth" for every method except "other." These differences are highly significant.

This section has argued that large firms do not seem to have a relative advantage over small firms in the use of recruitment methods which we would, a priori, have expected. In particular, they do not seem more likely to recruit workers through word-of-mouth. Why might this be the case? One plausible explanation is that large firms know their workers less well and are less likely to trust workers recommended to them. For example, some large shops refuse to recruit relatives or friends of existing workers for fear that they will find it easier to collude in shop-lifting. So, while the

TABLE 10.7
Determinants of Methods of Obtaining Job

	Replying to Job Ad	*Public Employment Service*	*Private Employment Agency*	*Direct Application*	*Other*
Log (workplace size)	0.111	0.025	0.495	0.148	−0.141
	(0.011)	(0.014)	(0.020)	(0.013)	(0.014)
Female	0.559	−0.069	0.190	0.156	−0.039
	(0.028)	(0.034)	(0.042)	(0.032)	(0.035)
Black	−0.142	0.000	−0.181	−0.017	−0.065
	(0.072)	(0.091)	(0.101)	(0.086)	(0.094)
Experience/10	0.070	−0.639	−0.084	−0.194	0.049
	(0.033)	(0.004)	(0.053)	(0.040)	(0.042)
(Experience/10) squared	−0.017	0.106	0.003	0.029	0.022
	(0.008)	(0.010)	(0.013)	(0.010)	(0.010)
Degree	0.703	−0.364	0.675	0.363	0.613
	(0.075)	(0.100)	(0.116)	(0.087)	(0.091)
A-Level	0.198	−0.044	0.205	0.144	0.006
	(0.074)	(0.094)	(0.117)	(0.086)	(0.091)
O-Level	0.049	0.170	0.099	−0.052	−0.083
	(0.072)	(0.089)	(0.113)	(0.083)	(0.087)
No qualification	−0.482	0.061	−0.903	−0.130	−0.442
	(0.077)	(0.094)	(0.132)	(0.088)	(0.093)
Number of observations	41972				
Pseudo-R^2	0.038				

Notes.
1. The estimated model is a multinomial logit where the omitted category is "heard through employee." The data used are as described in table 10.6.

flow of applicants through balanced matching may be larger in the large firms, the average quality may be lower.

10.5 Estimating the Labor Cost Function

Section 2.3 introduced the concept of the "labor cost function" as a way of thinking in more general terms about monopsony. Recall that the labor cost function, $C(w, N)$ is defined as the cost per worker of keeping employment at N if the employer pays a wage w. The most important elements of the labor cost function are likely to be recruitment and training costs. As this chapter is (at least in part) about the recruitment process, this seems the natural place to discuss empirical evidence on the form of the labor cost function. As discussed in chapter 2, the critical issue is whether there are diseconomies of scale in recruitment. This hypothesis is difficult to test as data on recruitment and training costs are hard to come by: for this reason we use a survey conducted by the UK Institute for Personnel Development (IPD) each year from 1997 to 1999. These surveys were the latest in a series of postal surveys of personnel professionals in the private and public sectors: there were 2016 respondents in our sample period. The survey asks questions about the number of staff that have left and been recruited over the previous year for ten broad occupational groups and on recruitment difficulties, redundancy, and, importantly from our point of view, the costs of labor turnover. The main weaknesses of these data are that the sample is non-representative, there is no information on wages, and only rudimentary information on workplace characteristics.

Respondents were asked to estimate the cost of turnover per individual employee: the answers were banded and are summarized in the first seven rows of table 10.8. Using mid-points of the bands, we get the estimates reported in the row of table 10.8 labeled "average turnover cost". From this, it might seem that turnover costs are much higher for the more skilled occupations. However, the labor cost function is defined as the cost per employee, not per recruit so that these estimates have to be multiplied by the turnover rate to get an amortized cost per employee. This reduces the differences in the turnover costs because turnover rates are higher for less-skilled workers. One also needs to evaluate these costs relative to weekly earnings. The penultimate row of table 10.8 shows weekly earnings from the LFS for comparable broad occupational groups. Turnover costs as a fraction of total labor costs are then presented in the final line. There no longer seems to be any particular relationship between turnover costs and skill levels so turnover costs would seem to be as important at the bottom end of the skills distribution as at the top.

TABLE 10.8
The Size of Turnover Costs: UK IPD Data

Turnover cost (£)	*Managerial*	*Professional*	*Technical*	*Clerical*	*Sales*	*Personal*	*Craft and Skilled*	*Operatives*	*Unskilled*
<750	6.0	3.7	6.0	23.9	15.3	31.7	35.5	63.1	44.8
750–1500	11.0	8.7	15.9	33.6	15.8	33.6	32.2	24.5	19.1
1500–3000	22.7	24.2	32.6	29.8	26.8	20.8	22.6	9.3	22.4
3000–5000	27.8	28.6	22.7	8.8	19.1	9.1	6.5	1.6	7.7
5000–7500	15.1	17.9	13.3	2.6	12.4	1.5	1.9	0.4	3.3
7500–10000	9.2	9.7	5.7	1.0	6.3	2.2	0.7	0.5	1.0
>10000	8.2	7.0	3.7	0.3	4.3	1.1	0.5	0.5	1.7
Average turnover cost	4749	4823	3736	1783	3574	1777	1528	1170	937
Turnover rate (% per year)	15.6	23.4	19.0	26.2	26.6	28.4	23.7	28.3	34.2
Turnover rate × turnover cost (£ per week)	15.2	20.6	14.1	10.1	17.7	7.4	7.5	6.5	6.3
Average weekly earnings	482	449	353	208	158	169	294	262	
Turnover cost as fraction of total cost	3.1	4.6	4.0	4.8	11.2	4.4	2.6	2.4	2.4

Suppose that the cost of a given level of recruits can be written as the following iso-elastic function of the wage, recruitment, and employment:

$$\ln C(w, R, N) \equiv \beta_0 - \beta_w \ln(w) + \beta_R \ln(R) - \beta_N \ln(N) \qquad (10.17)$$

Both the level of recruitment and employment are included to allow for the possibility (amongst others) that it is the ratio of recruitment to employment that determines the costs of recruitment. We would like to be able to estimate this function but, unfortunately, the IPD data has no information on wages. However, we can still obtain some insight into the marginal costs of recruitment. Assume that the separation rate can be written as $\ln(s) = s - \gamma \ln(w)$. Then, as $sN = R$, the labor cost function can be written as the following function of w and N:

$$\ln C(w, N) \equiv \beta_0 + \beta_R s - (\beta_w + \beta_R \gamma) \ln(w) + (\beta_R - \beta_N) \ln(N) \qquad (10.18)$$

so that it is $\beta \equiv \beta_R - \beta_N$ that determines whether there are diseconomies of scale in recruitment. The wage will be chosen to satisfy (2.12); the first-order condition for this can be written as

$$\ln(w) = \frac{(\beta_0 + \beta_R s) + \ln(\beta_w + \beta_R \gamma) + \beta \ln(N)}{1 + \beta_w + \beta_R \gamma} \qquad (10.19)$$

Substituting into (10.18) leads to

$$\ln C \equiv \frac{\beta_0 + \beta_R s + \beta \ln(N)}{1 + \beta_w + \gamma \beta_R} - \frac{\beta_w + \gamma \beta_R}{1 + \beta_w + \gamma \beta_R} \ln(\beta_w + \gamma \beta_R) \qquad (10.20)$$

(10.20) expresses the labor cost function in terms of N alone. Note, that the coefficient on N is not the β in which we are interested but $\beta/(1 + \beta_w + \gamma\beta_R)$ so the coefficient is biased towards zero. But one can still look to see whether there is evidence that $\beta > 0$.

In estimating (10.20) there is an endogeneity problem associated with the fact that unobserved differences in turnover costs that are in the error in our equation are likely to be negatively correlated with the level of employment. It is not clear that much can be done about this with the limited data available in the IPD data set except to notice that this will tend to bias our coefficients towards zero so that a finding that $\beta > 0$ remains convincing evidence against the hypothesis that $\beta = 0$.

Table 10.9 presents some estimates of the labor cost function of (10.20) using the IPD data. In the first row, all the observations are pooled together and job, sector, and year controls are included, and an interval regression is estimated as the dependent variable is banded. The coefficient on the log of employment is 0.060 and is significantly different from zero. This is evidence that $\beta > 0$ and the labor cost function is increasing in employment. The next row estimates the model by OLS using mid-points of the turnover cost bands as measures of the turnover costs: this

TABLE 10.9
The Costs of Recruitment: UK IPD Data

Sample	*Estimation Method*	*Coefficient on Ln(Employment)*	*Firm Controls*	*Sector Controls*	*Job Controls*	*Number of Observations*	R^2
All	Interval regression	0.060 (0.008)	No	Yes	Yes	4761	
All	OLS	0.059 (0.009)	No	Yes	Yes	4761	0.40
All	OLS	0.023 (0.008)	Yes	No	Yes	4819	0.61

Notes.
1. The dependent variable is for the log of the recruitment cost per worker. All regressions pool the responses for 1997–99. Sector dummies, job dummies (where appropriate), and year dummies are included. The classification of sectors differs in the two years so dummies for each sector–year combination are included. Regressions are weighted using the level of employment. All standard errors are hetero-scedastic consistent.

makes little difference to the estimated coefficient. The third row estimates a more demanding model where individual firm dummies are included. The coefficient drops (as we might expect from the likely increase in the importance of measurement error) but still remains significantly different from zero so that recruitment costs are significantly higher within firms in occupations where there is a high level of employment.

These results do suggest the presence of diseconomies of scale in recruitment but the quality of the data means that caution should be exercised in interpreting these results.

10.6 Lay-Offs

So far this chapter has discussed the decisions of employers on hiring and recruitment activities. But, this is only a partial picture of the employer policies that influence the level of employment in a firm: the other side of the coin is the decision to lay off existing workers.

The simple models we have worked with do not have an interesting model of lay-offs: we have simply assumed an exogenously given job destruction rate. An interesting theory of lay-offs requires some variation in productivity over time so that a worker who is profitably employed now need not be profitably employed in the future. There are a number of models of this type in the matching literature, starting with Mortensen and Pissarides (1994) who endeavor to explain the empirical regularities identified by Davis et al. (1996). One could readily develop similar models for wage-posting firms.

There are a number of implications from such models. First, if it is costly and/or difficult to hire workers, one will not fire workers immediately their productivity falls below their wage. The reason is that there will be some probability that their productivity will increase in the future. The result will be something like labor hoarding, where employment fluctuations are smoothed.

Second, lay-offs in the Mortensen–Pissarides model are voluntary: they only occur when there is no surplus left in the match. But, in reality, most lay-offs seem to be involuntary. There are a number of ways of generating this. As discussed in the previous chapter, lay-offs will typically be involuntary if some type of efficiency wage effect is at work: just as employers will not want to hire workers at their reservation wage, they will want to fire them before their wage is that low. Some type of wage rigidity can help to explain why lay-offs are involuntary. Employers undoubtedly have more market power over existing workers than new potential recruits. If an employer gets a reputation

for cutting wages (for reasons that may be hard to justify to workers), this may hinder their ability to recruit workers. Lay-offs are different from wage cuts in that the former hurt both employers and workers, whereas the latter benefit employers. Hence, there are good reasons to think that lay-offs will be primarily involuntary.

10.7 Conclusions

This chapter discusses the process by which firms recruit workers. This takes the place of the labor demand curve in more traditional labor economics. A theoretical framework is provided for interpreting vacancy statistics based on it being costly to create jobs and the supply of labor to a firm being stochastic. We have argued that this framework can easily explain the stylized facts about vacancies (that vacancy rates and vacancy durations are typically very low) and these facts are perfectly compatible with employers having non-negligible market power. The channels by which employers recruit workers has been discussed; we found that there is little evidence that large employers have an advantage over small employers because of the importance of personal contacts in the recruitment process. Finally, some evidence on recruitment and training costs has been presented to suggest that employers do face increasing marginal costs of recruitment as is required for employers to have market power.

Appendix 10

Proof of Proposition 10.1

The easiest way to see the validity of (10.5) is to consider the steady state of a process in which f_A might change over time. So, let us denote by $f_A(\tau)$ the probability of A potential workers at time τ and by $f_A(\tau+\Delta)$ the probability a short time Δ later. We must have

$$f_A(\tau+\Delta) = [1 - r_A\Delta - s_A\Delta]f_A(\tau) + s_{A+1}\Delta f_{A+1}(\tau) + r_{A-1}\Delta f_{A-1}(\tau) \tag{10.21}$$

(10.21) says that the probability of having A potential workers at $(\tau+\Delta)$ is the probability of A workers at τ multiplied by the probability that no-one has left or arrived plus the probability there were $(A+1)$ workers at τ and one has left plus the probability there were $(A-1)$ workers at τ and one has arrived. In a steady-state, we must have $f_A(\tau+\Delta) = f_A(\tau)$ in which case (10.21) becomes

$$(r_A + s_A)f_A = s_{A+1}f_{A+1} + r_{A-1}f_{A-1} \tag{10.22}$$

which can be thought of as saying that separations equal recruits. One can readily verify that $f_{A+1} = (r_A f_A)/s_{A+1}$ implies (10.22) and repeated substitution leads to (10.5).

If $r_A(w, K) = r(w)$ and $s_A(w, J) = s(w)A$, substitution into (10.5) confirms that (10.6) is the solution.

Proof of Proposition 10.2

The expected level of employment $E(N)$ is given by

$$E(N) = \int \min[A, J]f(A)dA = \int^{J} Af(A)dA + J\int_{J} f(A)dA \tag{10.23}$$

Using the fact that $A \sim N(N(w), N(w))$, the definition of X as $X = [J - N(w)]/\sqrt{N(w)}$ and well-known results on means of truncated normal distributions (see Maddala 1983), (10.23) can be written as

$$E(N) = N(w) - \sqrt{N(w)}[\phi(X) - X(1 - \Phi(X))] \tag{10.24}$$

where $\phi(\cdot)$ is the density function for the standard normal distribution. Hence, profits in (10.7) can be written as

$$\pi = (p - c - w)N(w) - \sqrt{N(w)}[(p - w)[\phi(X) - X(1 - \Phi(X))] + cX] \tag{10.25}$$

Taking the first-order condition of (10.25) with respect to X, and using the fact that for the standard normal $\phi'(X) = -X\phi(X)$, leads to (10.8). Taking the first-order condition with respect to the wage leads to

$$\begin{aligned}&(p - c - w)N'(w) - N(w)\\&- \frac{1}{2}\frac{N'(w)}{\sqrt{N(w)}}[(p - w)[\phi(X) - X(1 - \Phi(X))] + cX]\\&+ \sqrt{N(w)}[\phi(X) - X(1 - \Phi(X))]\end{aligned} \tag{10.26}$$

which, using (10.24) to eliminate $[\phi(X) - X(1 - \Phi(X))]$ can be written as

$$(p - c - w)N'(w) - N(w) - \frac{1}{2}\frac{N'(w)}{\sqrt{N(w)}}\left[(p-w)\frac{N(w)-E(N)}{\sqrt{N(w)}} + cX\right]$$
$$+ [N(w) - E(N)] \tag{10.27}$$

which, using the definition of X and after some re-arrangement, can be written as (10.9).

Proof of Proposition 10.3

1. The probability of a vacancy is the probability that $A \leq J$ which is given by $\Phi(X)$, that is, (10.10).

2. The vacancy rate measured as a fraction of total jobs is $(J - E(N))/J$. Expected employment $E(N)$ is given by (10.24) and $J = N(w) + X\sqrt{N(w)}$ so that this can be written as (10.11).

3. One might also be interested in the expected number of applicants that are received when a vacancy occurs. Suppose, prior to the vacancy occurring, there were A in the pool. Then, given that one of these must have left the firm, the initial number of applicants must be given by $\max(A - J, 0)$. But the expected number of applicants is not simply $E(\max(A - J, 0)$ as vacancies are more likely to occur when employment is larger. Denote by $f^v(A)$ the probability of being in state A given that a vacancy is just about to occur. Then, given our assumption about the processes generating arrivals and separations, we must have the following relationship between $f^v(A)$ and $f(A)$:

$$f^v(A) = \frac{s\min(A,J)f(A)}{s\int \min(a,J)f(a)da} = \frac{\min(A,J)f(A)}{E(N)} \tag{10.28}$$

The expected number of initial applicants is then given by

$$\text{expected number of applicants} = \frac{\int \max(A-J,0)\min(A,J)f(A)dA}{E(N)}$$
$$= \frac{J\int_J (A-J)f(A)dA}{E(N)} \tag{10.29}$$

which, using the standard features of the expectation of a truncated standard normal and the definition of J is (10.12).

4. Assume, without loss of generality that vacancies are filled in on a first in, first out principle so that outstanding vacancies must be filled before any new vacancy. Suppose that a vacancy occurs when the initial

state was A so that this vacancy will only be filled when $(J - A)$ workers have arrived. With the assumption of a Poisson arrival process of rate r the expected time of arrival of $(J - A)$ workers is given by $(J - A)/r$. Hence, the expected vacancy duration is given by

$$\text{expected vacancy duration} = \frac{1}{r}\int \max(J - A, 0) f^{v}(A) dA$$

$$= \frac{\int^{J} (J - A) A f(A)}{rE(N)} dA \qquad (10.30)$$

where the second equality follows from (10.28). Converting to X this can be written as

$$\int^{J} (J - A) A f(A) dA = \sqrt{N(w)} \int^{X} (X - x)\left[N(w) + x\sqrt{N(w)}\right]\phi(x) dx \qquad (10.31)$$

which leads to (10.13).

11

Human Capital and Training

THIS chapter discusses the economics of human capital acquisition and training. There is a well-established, competitive market approach to this subject perhaps best represented by Becker's classic book *Human Capital* (Becker 1993). Becker's book is justly famous for its distinction between general human capital (skills that are perfectly transferable between employers) and specific human capital (skills of use to only one employer). Becker argued that workers will bear the cost of investment in general human capital as competition among employers will ensure that the wage is always equal to the marginal product so that workers will appropriate all the returns to investment. On the other hand, employers should bear the cost of investment in specific human capital as they reap the gains from this investment.[1] Furthermore, he argued that there is no reason why a competitive market (which should include a well-functioning capital market) should not provide the efficient level of training so that there is little or no case for government intervention.

Although Becker's approach dominates economic thinking about training, it is not without its problems. In particular, employers often seem to pay for the acquisition of general skills by their workers, something that should not happen in Becker's world. While it is always possible to argue that the skills being given to workers are specific, there remains a strong suspicion that this is not really true. Related to this, it seems hard to find evidence that, other things being equal, workers offered general training for which they do not pay directly are paid less than those who are not.

This chapter discusses the way in which Becker's analysis needs to be modified if employers have some market power over their workers. It discusses whether the level of investment in human capital is efficient in such a market, who will be trained, and what the consequences will be. Introducing frictions in the labor market introduces certain ambiguities in Becker's celebrated definition of general and specific human capital that were recognized by Becker himself. The reason is that frictions in the labor market make it costly (in terms of time and/or money) for a worker

[1] The conclusion about specific investments is often modified to say that both the returns to and the costs of specific investments should be shared between worker and employer in order to deter quits. As, discussed in chapter 5, this conclusion implicitly relies on the assumption that the labor market is monopsonistic.

to move from one firm to another so that the productivity of a worker is always strictly above what it is in their next best alternative. Becker (1993: 50) states that, "in extreme types of monopsony ... all training, no matter what its nature would be specific to the firm." Using this argument, the classification of a particular skill as general or specific is determined not just by technological factors but also by the nature of the labor market. Although Becker hints that monopsony in the labor market simply affects the way one classifies skills as general or specific, and hence has implications about who should pay for training but no necessary implications for the efficiency of the market for human capital acquisition, he provides no formal analysis and this chapter demonstrates that this is not generally the case.

Hence, one is left with the choice between accepting Becker's definition of the generality of skills as determined by market structure as well as technology but dropping his conclusion that the market for training will always be efficient, or to base the classification of skills as general or specific solely on technology and accept that Becker's analysis only applies to competitive markets. The latter seems the better course of action as it preserves more of Becker's contribution. So, this chapter follows Stevens (1994) in assuming that general training raises the productivity of the worker by the same amount in all similar firms (even if it is costly to find them)—Stevens (1994) terms this transferable training—and specific training only affects the productivity in this firm.

Three types of skill acquisition are discussed in this chapter. The first section considers the incentives for workers to engage in general premarket training (that should be thought of as full-time education before entry to the labor market). The second section then considers the provision of general training within firms and the third section the provision of specific training. The presumption is that there will be under-investment in training, the intuition for which is that part of the returns to general skills will accrue to future employers who cannot be internalized in the decision-making. The chapter concludes with a discussion of the empirical literature on training.

11.1 Acquiring Education

This section considers the decision to invest in human capital outside of firms: this can be thought of as a decision about how much education to acquire.

Assume there are only two types of labor, unskilled and skilled. Assume that the marginal product of the skilled (denoted by p_1) is above that of

the unskilled (denoted by p_0). Further, assume that, for technological reasons, training can only be undertaken outside firms and that each unskilled worker can be transformed into a skilled worker at a one-off cost of c. Assume that training takes no time (think of it as a costly injection) but this could be relaxed very simply and nothing of importance depends on it.

In a perfectly competitive market, the wages received by both types of worker will be their respective marginal products. As workers receive all the returns from their investment, their decision to invest (or not) will be the efficient one.

In an oligopsonistic labor market, the differences in productivity will be reflected in differences in the wage offer distribution facing skilled and unskilled workers but the wages offered will be below the marginal products. Denote the unskilled wage offer distribution by $w_0(F)$ and the skilled wage offer distribution by $w_1(F)$ where F is the position in the wage-offer distribution. This section considers only a partial equilibrium model so will treat these wage offer distributions as given: it is a simple matter to embed the model that follows into a general equilibrium framework.

On the matching side, make a familiar set of assumptions. Workers die at a rate δ_r to be replaced by workers who initially enter unemployment and are unskilled. Employed workers also leave employment for unemployment at an exogenous rate δ_u. All workers, both skilled and unskilled, both employed and unemployed, are assumed to receive job offers at a rate λ. Note that these assumptions imply that the employment rates for skilled and unskilled workers are identical: a plausible extension would be to modify the assumptions so that the educated are more likely to be in employment—the implication of doing this is discussed later.

Denote the value of being an unemployed unskilled worker by V_0^u and of an unemployed skilled worker by V_1^u. Workers will train if $[V_1^u - V_0^u] > c$. We are interested in how this condition differs in a monopsonistic labor market from what we would have in a competitive market. The value functions for unskilled and skilled workers can be written as

$$\delta_r V_i(F) = w_i(F) - \delta_u[V_i(F) - V_i^u] + \lambda \int_F^1 [V_i(f) - V_i(F)]df \quad (11.1)$$

$$\delta_r V_i^u = b + \lambda \int_0^1 [V_i(f) - V_i^u]df \quad (11.2)$$

where $V_i(F)$ is the value of being an employed worker of type i at position F in the wage distribution. A very useful result is the following.

Proposition 11.1. *The value of being unemployed can be written as*

$$\delta_r V_i^u = \frac{\delta b + \lambda E(w_i)}{\delta + \lambda} \tag{11.3}$$

Proof. See Appendix 11.

(11.3) says that the value of a job is a weighted average of the utility obtainable when out of work and the average wage when in work, the weight on the average wage being the employment rate. Using (11.3) one can provide a simple analysis of the incentives to acquire education. In a competitive labor market we would have $E(w_i) = p_i$ so that individuals will acquire skills if

$$\frac{1}{\delta_r} \frac{\lambda}{\delta + \lambda} [p_1 - p_0] > c \tag{11.4}$$

This is, of course, the efficient condition. There is a simple intuition for it. Being skilled only offers a return if the individual is employed so the difference in productivities is multiplied by the employment rate $\lambda/(\delta + \lambda)$ and also by the expected lifetime $1/\delta_r$.

In a monopsonistic labor market the condition for investment in skills becomes

$$\frac{1}{\delta_r} \frac{\lambda}{\delta + \lambda} [E(w_1) - E(w_0)] > c \tag{11.5}$$

This is more (less) restrictive than the efficiency condition if $[E(w_1) - E(w_0)] < (>) [p_1 - p_0]$, that is, if the difference in expected wages is less (greater) than the difference in productivities.

The relationship between the gap in wages and the gap in productivity is something that will recur later in the chapter. It also occurs in other papers on training in imperfect labor markets, notably Acemoglu and Pischke (1999a) who investigate the consequences of "wage compression" where the gap in wages is less than the gap in productivities.

They present a number of arguments for why wage compression might exist and argue that one should think of it as the "normal" case. Not all of their arguments are about monopsony but the presence of monopsony might also expect one to think that wage compression is the most likely outcome. For example, in the general equilibrium version of this model considered in chapter 2, expected wages are given by (2.26). Or, using the simplest monopsony model, we have that wages are proportional to productivity (see (2.3)) so that, if the rate of exploitation is the same for skilled and unskilled workers, the wage gap is less than the productivity gap. So, there is reason for believing that wage compression is the "normal" case, the consequence of which is that there is too little invest-

ment in human capital in a monopsonistic labor market. There is under-investment in the above model because workers get paid less than their marginal product when in work and the gap between wage and marginal product rises with the level of productivity

However, there are some grounds for caution in drawing this conclusion. The analysis above has been based on the assumption that the markets for skilled and unskilled labor are equally monopsonistic. There is no particular reason to believe this is the case. For example, table 2.2 showed that the fraction of recruits from non-employment is lower for better-educated workers. Hence, we might expect the labor market for educated labor to be less monopsonistic than that for the less-educated. This is not really surprising: there is more profit to be had from exploiting more skilled workers, so more firms will enter that segment of the labor market which can be expected to drive up skilled wages. But, it does mean that wages for the skilled may be closer to marginal product than for the unskilled in which case it is possible that wage compression does not exist and there is over-investment in the acquisition of skills as workers try to move into segments of the labor market where they are less exploited.

In a monopsonistic labor market the under-investment problem may not be as serious as this section has suggested because it is possible that firms have some incentive to pay for the training of unskilled workers for the simple reason that they can make profits on these workers without them leaving immediately. As much training is carried out within firms, we now turn to an analysis of this case.

11.2 Employer-Provided General Training

This section discusses the implications of monopsony for the provision by employers of general training. In Becker's analysis, employers will only provide such training if workers fully compensate them for it and, provided this condition is satisfied, it will be provided at the efficient level. These predictions are not in line with most empirical evidence which finds that employers often bear a substantial part of the of cost of general training (e.g., Acemoglu and Pischke 1999b cite estimates of the substantial costs of apprentices to German firms). A small literature has grown up to explain these findings, for example, see Katz and Ziderman (1990), Stevens (1994), Acemoglu and Pischke (1998), and Autor (2001) among others. All of these papers essentially assume some mechanism by which employers have some ex post monopsony power over their employees so that employers can extract some part of the return to general training.

As in the previous section, assume that there are only two types of worker, skilled and unskilled. It costs c to convert an unskilled worker into a skilled one. Assume that this training can be provided while in employment.[2]

In modeling the provision of training, an important first decision is about the form of contracts that can be offered by employers. Suppose that the employer can only offer an unskilled wage and a skilled wage. In this case, training a worker appears to cost the employer the full amount c as the worker does not appear to pay anything towards it. But, as has been pointed out many times before, this conclusion is not right as the provision of training will make the firm a more attractive employer to unskilled workers and hence allow the employer to reduce the unskilled wage while continuing to attract as many unskilled workers as before. An alternative contract is one in which the employer, as before, pays an unskilled and a skilled wage but can, when it trains unskilled workers, charge them directly for the privilege. The amount that can be charged to workers is the gain to them from becoming skilled. One might think that introducing this extra degree of freedom in the contract that can be offered by an employer would enable it to increase profits. But, the following proposition shows that this extra degree of freedom is worth nothing to the employer.

Proposition 11.2. *The employer makes exactly the same level of profit whether or not it can directly charge workers for being trained. If the unskilled wage in the contract where workers do not pay a direct cost is $\tilde{w}_0$, and the unskilled wage when they do pay a direct cost is w_0, then the relationship between the two is given by*

$$\tilde{w}_0 = w_0 - \chi(V_1 - V_0) \qquad (11.6)$$

where χ is the rate at which workers are trained, V_0 and V_1 are the values of being unskilled and skilled in the firm which are given by

$$\delta_r V_1 = w_1 - \delta_u[V_1 - V_1^u] + \lambda \int_{w_1} [V(w_1) - V_1] dF_1(w_1) \qquad (11.7)$$

and

$$\delta_r V_0 = w_0 - \delta_u[V_0 - V_0^u] + \lambda \int_{w_0} [V(w_0) - V_0] dF_0(w_0) \qquad (11.8)$$

Proof. See Appendix 11.

[2] There is an issue here as to whether the employer is the only possible provider of general training or whether workers can, if they so desire, obtain the training themselves from another provider. One way of thinking about this issue is whether employers should be thought of as having market power in the provision of training.

The fact that employers do not gain from charging workers directly for their training perhaps explains why this institution is rarely observed. However, from the conceptual point of view, it is much easier to assume that there is a direct charge. The reason is that it is then only the unskilled wage that affects the value of the job to the unskilled and that the share of the costs of training borne by the worker is clearly $V_1 - V_0$. So, the analysis proceeds on the assumption that this is the case. But, if one wanted to convert the theoretical variables to the observed, it would probably be better to assume that the unskilled wage is the $\tilde{w}_0$ given by (11.6) as direct payments by workers for training are not commonly observed. It is worth noting that this equivalence result does depend on there being no restriction on wages: if, for example, there is lower bound to unskilled wages (e.g., because of capital market constraints on workers or minimum wages) then the equivalence result may fail and a different analysis would be needed.[3]

Assume the employer has a revenue function $Y(N_0, N_1)$ where N_0 is unskilled employment and N_1 is skilled employment. Denote by p_0 the marginal product of unskilled labor and by p_1 the marginal product of skilled labor. If T is the level of training, then the employer's level of profits will be given by

$$\pi = Y(N_0, N_1) - w_1 N_1 - w_0 N_0 - [c - (V_1 - V_0)]T \qquad (11.9)$$

where the value functions are given by (11.7) and (11.8). The levels of skilled and unskilled employment will depend on the wages paid and the level of training intensity according to the equations

$$s_0(w_0)N_0 = R_0(w_0) - T \qquad (11.10)$$

and

$$s_1(w_1)N_1 = R_1(w_1) + T \qquad (11.11)$$

where s and R are the separation and recruitment rates which, in a monopsonistic labor market, will depend on the wage paid.

Using (11.10) and (11.11) to eliminate employment levels from (11.9), one can write profits as

$$\pi = Y\left(\frac{R_1(w_1) + T}{s_1(w_1)}, \frac{R_0(w_0) - T}{s_0(w_0)}\right) - w_1 \frac{R_1(w_1) + T}{s_1(w_1)}$$

$$-w_0 \frac{R_0(w_0) - T}{s_0(w_0)} - [c - (V_1 - V_0)]T \qquad (11.12)$$

and the employer maximization problem is to choose (w_0, w_1, T) to maximize this.

[3] There is a parellel here to the discussion of the discriminating monopsonist in chapter 5.

The following proposition contains the first-order conditions for profit maximization.

Proposition 11.3. *The first-order condition for profit maximization for the unskilled wage can be written as*

$$w_0 = \frac{\varepsilon_0^R - \varepsilon_0^s(1-\theta_0)}{1 + \varepsilon_0^R - \varepsilon_0^s(1-\theta_0)} p_0 \tag{11.13}$$

where ε_0^R is the elasticity of unskilled recruits with respect to the wage, ε_0^s is the elasticity of the unskilled separation rate with respect to the wage, and θ_0 is the ratio of the flow trainees to the flow of unskilled recruits

$$\theta_0 = \frac{T}{R_0} \tag{11.14}$$

For the skilled workers' wage, the first-order condition can be written as

$$w_1 = \frac{\varepsilon_1^R - \varepsilon_1^s(1+\theta_1)}{1 + \varepsilon_1^R - \varepsilon_1^s(1+\theta_1)} p_1 \tag{11.15}$$

where the elasticities are those applicable to the recruitment and separation of skilled workers and θ_1 is the ratio of skilled workers recruited internally through training to those recruited externally, that is,

$$\theta_1 = \frac{T}{R_1} = \theta_0 \frac{R_0}{R_1} \tag{11.16}$$

The first-order condition for the level of training can be written as

$$\left[\frac{p_1 - w_1}{s_1} + V_1\right] - \left[\frac{p_0 - w_0}{s_0} + V_0\right] - c = 0 \tag{11.17}$$

Proof. See Appendix 11.

First, consider the intuition for the expressions for the wages in (11.13) and (11.15). As is usual, the relationship between wages and productivity is determined by the wage elasticities of the recruitment and separation rates. But, in addition, the training intensity of the firm affects wages (as measured by θ_i).

The unskilled wage is declining in the fraction of the unskilled trained as the employer becomes less concerned with deterring separations among this group as the fraction of them exiting to being skilled workers rises. On

the other hand, the skilled wage is increasing in the fraction that are recruited through training. The intuition here is that a high skilled wage can, in part, be recouped through the payment for training extracted from the unskilled and this effect becomes more important, the larger this group is in relation to skilled workers recruited from outside the firm.

Note also that (11.13) and (11.15) imply that, even if the recruitment and separation elasticities for skilled and unskilled workers are the same, the rate of exploitation will be higher for the unskilled than for the skilled as long as there is any training. Hence, there is reason to think that the labor market for the less-skilled is more monopsonistic as discussed at the end of the previous section.

Turning to the first-order condition for training, (11.17), there is a very simple intuition. $[(p_i - w_i)/s_i] + V_i$ is the sum of the returns to employer and worker of having skill level i. So, (11.17) says that workers will be trained if the returns to employer and worker from doing so exceeds the costs. Note, that because workers can be charged for the training (either explicitly or implicitly, depending on the contract), returns to all parties within the firm are internalized in the training decision. But, as discussed below, this does not mean the training decision is efficient as future employers of the worker may also benefit from training and their interests are not represented in the first-order condition.[4]

Becker's analysis is readily understood using Proposition 11.2. If the labor market is perfectly competitive, then the recruitment and separation elasticities are infinite: (11.13) and (11.15) then imply that wages will be equal to marginal products. Given this, (11.17) then says that it is only the workers who will reap any returns from the investment and they will invest if the return exceeds the cost. If all other employers also pay a wage equal to the marginal product then it is simple to show that the investment decision is the efficient one.

The case of a perfectly competitive market is simple but the general case of a monopsonistic labor market is more difficult because it is so messy. The wage elasticities of recruitment and separations may differ by skill, the separation rates may differ. To simplify matters, let us start by assuming that, within each employer, the separation rates for unskilled and skilled workers are the same: one might think of this as the case where employers choose the same position in the skilled and unskilled workers' wage distribution. In this case, the crucial question is whether or not there is wage compression, that is, how the wage differential $(w_1 - w_0)$ compares with the productivity differential $(p_1 - p_0)$ as the following proposition shows.

[4] Note this is different from the assumption made in Acemoglu and Pischke (1999b) that workers cannot be made to contribute towards the cost of their training.

Proposition 11.4

1. *If* $(p_1 - p_0) > (w_1 - w_0)$ *in this employer then employers will bear part of the cost of general training.*

2. *If* $(p_1 - p_0) > (w_1 - w_0)$ *in all employers then there will be under-investment in training.*

Proof. The proof of this is very simple and will not be relegated to the appendix. If the separation rates of unskilled and skilled workers are identical within each firm, then re-arrangement of (11.17) shows that we must have $c > (V_1 - V_0)$ if $(p_1 - p_0) > (w_1 - w_0)$ so that not all the cost of training can be recouped from workers. Hence, employers must be bearing part of the cost of the general training that is done.

If $(p_1 - p_0) > (w_1 - w_0)$ in all firms, then this implies that the profits of all potential future employers of a worker are increased when the worker is trained. As these potential future employers are not internalized in the training decision, there must then be under-investment.

This proposition can be interpreted as simply a confirmation of Becker's intuition that the costs of training will be paid for by those who reap the returns. The difference from his analysis is that employers in a monopsonistic labor market can expect to get some of the returns even from general training.

One of the implications of the second part of the proposition is that the extent of monopsony in the labor market is likely to affect the extent of under-investment. As explained above, a perfectly competitive labor market is (in the absence of capital market imperfections) likely to deliver an efficient level of training as no potential future employers of a worker can expect to make any profits on them. At the other extreme, a very monopsonistic labor market[5] may also deliver training close to the efficient level as there are few future employers to make profits out of the worker. This point is made at greater length in Stevens (1994).

The weakness of Proposition 11.4 is that it does nothing to prove that $(p_1 - p_0) > (w_1 - w_0)$. As discussed in the previous section, one might expect that this is the "normal" case for a number of reasons. First, inspection of (11.13) and (11.14) shows that, if elasticities are the same, then we might expect skilled and unskilled wages to be a similar fraction of productivities. However, as discussed above, skilled wages will be a higher fraction of productivity than unskilled wages. One could also point to the few

[5] One should include implicit or explicit agreements among employers not to poach skilled workers from each other as a very monopsonistic market arrangement: such agreements are often said to help to foster employer-provided training.

studies that attempt to estimate both the productivity and wage impacts of training as evidence in favor of wage compression. Barron et al. (1997, chapter 6), using US data, find much larger effects of training on productivity than wages although the effects on productivity are so large that one might not want to examine them too closely.

Are there any testable predictions about the types of employers where training will take place? The theory predicts, unsurprisingly, that training is more likely where the benefits are larger and the costs smaller. The benefits are likely to be larger where the current employer and worker are better able to internalize the returns from training. Hence, one might expect the returns to training to be higher in employers that are further up the wage distribution. To see how this is possible, suppose that the employer chooses a skilled and unskilled wage at the same point in the distribution: denote this by F. Further, assume that the separation rate only depends on F. Then, the left-hand side of (11.17), the benefits from training, $\Omega(F)$, can be written as

$$\Omega(F) = \frac{\Delta p(F) - \Delta w(F)}{s(F)} + \Delta V(F) \qquad (11.18)$$

where $\Delta x = (x_1 - x_0)$. Differentiating (11.18) with respect to F leads to

$$\begin{aligned}\Omega'(F) &= \frac{\Delta p'(F) - \Delta w'(F)}{s(F)} + \Delta V'(F) - \frac{s'(F)}{s(F)}[\Delta p(F) - \Delta w(F)] \\ &= \frac{\Delta p'(F)}{s(F)} - \frac{s'(F)}{s(F)}[\Delta p(F) - \Delta w(F)] \qquad (11.19)\end{aligned}$$

If there is wage compression so that $(p_1 - p_0) > (w_1 - w_0)$, the second term in (11.19) is positive suggesting that the incentives to train are higher in "better" firms. The first term is also likely to be positive, for example, if the better firms have a higher marginal product for everyone, it seems unlikely that the gap in productivities is smaller. Hence, the monopsony model has the prediction that we would expect to see more training in employers who are further up the wage distribution, essentially because a higher fraction of the returns will be internalized within firms. There are some concerns about the robustness of this conclusion. Firms higher up the wage distribution will have lower separation rates and, if training is primarily concerned with induction of new employees, may be associated with less training for this reason.

The fact that higher-wage employers may have a bigger incentive to train has the potential to explain the empirical anomaly that it is very hard, if not impossible, to find evidence of the competitive prediction that firms that offer training should pay their unskilled workers a lower wage (a compensating wage differential). Many researchers have tried to look for this rela-

tionship but most reach the same conclusion as Barron et al. (1997: 3) that "there is little evidence that training substantially reduces the starting wage." If those firms offering training are further up the unskilled worker wage distribution then there is no reason for this prediction to be true.[6]

11.3 On-the-Job Specific Training

This section considers the provision of specific training by employers. Becker's analysis suggested that workers should capture a smaller portion of the returns to specific as opposed to general training and that employers should bear some of the cost. As we shall see, this prediction does not necessarily hold up in a monopsonistic labor market.

One can use a modified version of the set-up of the previous section to discuss the provision of specific training. The first modification is that the employer cannot recruit any skilled workers from other employers: hence $R_1 = 0$. Secondly, as specific skills have no value elsewhere in the labor market, it is reasonable to assume that the separation rates and value functions of skilled and unskilled workers will depend only on the wage paid in this employer. Hence, if the employer pays their skilled workers a higher wage than the unskilled, the separation rate of skilled workers will be lower than that of the unskilled.

With these modifications, the first-order conditions in Proposition 11.3 can be used to discuss the optimal policy. First, consider the optimal skilled wage. As there are no skilled recruits, (11.16) says that we will have $\theta_1 = \infty$. (11.15) then says that the optimal policy is to set $w_1 = p_1$, that is, the employer should pay skilled workers their marginal product. As the optimal policy for the case of general skills is to pay a wage less than the marginal product, this implies that workers capture a larger share of the returns within the employer. This is in striking contrast to Becker's conclusion that workers should get a larger share of the returns to general training.

Where does this result come from? The explanation lies in the fact that the employer cannot recruit any workers with specific skills from outside the firm. If workers with general skills are paid their marginal products, then the employer is forgoing potential profits from externally recruited workers. In contrast, paying a high wage to internally trained skilled workers is not so costly to the employer as it can be clawed back in the form of a lower unskilled wage.

One must be a little cautious here. The discussion of wage discrimination in chapter 5 concluded that employers would like to use upward-

[6] This argument is identical to the one discussed in chapter 8 about why one often fails to find evidence of compensating wage differentials.

sloping wage–tenure profiles to extract more rents from workers. In the model of training presented here, there is a correlation between skill and job tenure because those who have been in the firm longer are more likely to have received specific training. So, the high wage returns to workers with specific skills may be an indirect way of achieving an upward-sloping wage–tenure profile when we have not explicitly allowed for it in the analysis. In this case, it may be that allowing for upward-sloping wage–tenure profiles would overturn the result described above. On the other hand, it was argued in chapter 5 that employers generally have a shortage of tools they can use in their attempt to be discriminating monopsonists so it may well be that they use every mechanism (direct or indirect) at their disposal including that of generously rewarding employees with firm-specific skills.

Perhaps it is safest to conclude that it is not so obvious in a monopsonistic labor market that workers pay for or get a larger share of the returns of general training than for specific training.

11.4 Empirical Analyses of Training

There is a large empirical literature on training. Among the questions that this literature seeks to answer are:

- To what extent is training general or specific?
- Who pays the direct costs of training?
- Who receives training?
- What is the impact of training on current wages?
- What is the impact of training on future wages?
- What is the impact of training on labor turnover?
- What is the impact of training on productivity?

However, the literature on many of these empirical correlations is confusing because there are too many endogenous variables and not enough exogenous ones, and because measures of training are often very vague. For example, wages and training receipt are almost certainly determined simultaneously (as in the models described above) and, while a number of papers attempt to use instrumental variables to deal with this problem, good instruments are rarely available.

There are also many papers in the empirical literature that look for evidence in support of the predictions of Becker's analysis. The prediction that the market will provide the efficient level of training is not really testable so attention focuses on predictions about the different allocations of costs and returns to general and specific training. But, distinguishing between general and specific training is not very easy and it is relatively

easy to explain away anomalous results as the consequence of problems with the data.

Bearing this in mind, the following discussion briefly summarizes the main empirical findings in this area and attempts to point out where monopsony can help to explain empirical findings that the human capital model cannot. But, the bottom line is that the empirical results are sufficiently confusing that it is often hard to present a very clear conclusion and one cannot really use these results to provide a clear distinction between the human capital and monopsony perspective. There is one very important exception to this negative conclusion: monopsony can explain why employers often seem to pay for general training, a major anomaly from the perspective of Becker's analysis.

11.4.1 Is Training General or Specific?

It is difficult to assess whether training is primarily general or specific and there are a number of methods used in the literature. First, some surveys contain questions which seek direct answers about the generality of skills acquired in training: for example, Loewenstein and Spletzer (1999) report that in the 1993 NLSY, 63% of workers reported that all or almost all of the skills learned were useful in doing the same kind of work for another employer while, at the opposite extreme, only 11% of workers said that less than half of the skills acquired were useful to other employers. They also reported similar findings from the 1992 EOPP survey. This evidence strongly suggests that on-the-job training is primarily general.

But, most studies do not have such direct questions on the content of training, and other empirical studies that attempt to distinguish between general and specific training use either information on the place where training takes place (on the grounds that training in the workplace is more likely to be specific and training at an external educational institution is almost certain to be general) or on who pays for it (relying on Becker's conclusion that employer-paid training is more likely to be specific). Lynch (1992) and Royalty (1996) are examples of papers that use the former approach while Loewenstein and Spletzer (1998) and Veum (1997) use both. It seems plausible to believe there is some useful content in these distinctions but these measures are less than perfect.

11.4.2 Who Pays the Direct Costs of Training?

The consensus here is that, with the exception of training undertaken by individuals at their own initiative, employers pay most of the monetary costs of training. For example, Loewenstein and Spletzer (1998) report, using the NLSY, that employers pay for 96% of formal company training,

91% of seminars at work, 82% of seminars outside work, but only 42% of training at colleges (e.g., business schools or vocational institutes).

As earlier discussions have made clear, this does not mean that employers are paying the cost of training as it may be that workers indirectly bear the costs by accepting lower wages (and one should also not ignore the time cost of training which may be explicitly borne by workers). But, this empirical finding does help to focus attention on trainee wages in the attempt to see whether workers are paying for their training.

11.4.3 *Who receives training?*

The human capital approach to training suggests that it is benefits relative to costs that determine the receipt of training. These factors are also important in monopsony but one would also add the importance of the extent of competition in the labor market and the position of employers in the wage distribution. As these are the distinctive contributions of monopsony, the following discussion concentrates on the evidence about their impact.

A number of commentators have argued that the institutional structure of the German labor market makes it less likely that workers trained within the firm will leave to work for other employers (see, e.g., Soskice 1994, or the evidence presented in Harhoff and Kane 1997). Furthermore, it is argued that this accounts for the more extensive apprenticeship system in Germany. Crucial to this argument is the idea that industry-level bargaining in Germany means that there is little wage variation across employers so that those who have completed apprenticeships have little incentive to move. Furthermore, as Acemoglu and Pischke (1998) argue, those who do leave the employer where they have been trained may also be sending a signal that they are low quality. They present evidence that those who change employers have lower wages than those who stay but that this is not true for those who change employers because of an intervening period of military service (which can be taken to signal nothing about worker quality).

In addition, it is sometimes argued that collective employer organizations have much more power over those employers who are seen to be poaching workers from other employers in Germany than elsewhere. As a result of all these factors, it is argued that German employers are often prepared to spend large amounts of money to equip their workers with general skills.

Looking for evidence that those employers who are further up the wage distribution do more training is more difficult because of a number of complicating factors. First, there is strong evidence (see, e.g., Altonji and Spletzer 1991, for the United States and Blundell et al. 1996, for the

United Kingdom) that the more able tend to receive more training. However, there are a number of areas where there is evidence consistent with these predictions.

First, for German apprenticeships it does appear to be the case that large firms both spend more on training and retain more of their apprentices which is consistent with this prediction (see Euwals and Winkelmann 2001).

The literature on the impact of unions on training may also be informative. Trade unions may have an impact on training through a number of routes. First, if they reduce the wage gap between unskilled and skilled workers, this reduction in wage compression would be expected to increase the incentives for employers to provide training (Acemoglu and Pischke 1999b make this argument). But even if unions simply raise wages for all workers of an employer then we would expect there to be an increase in training as this move up the wage distribution will reduce the quit rate to other employers and lead to a greater internalization of the returns to training. The US evidence is very mixed with some studies reporting negative impacts of unions on training and some positive. However, the UK evidence is very clear: Green et al. (1999) show that trade unions are associated with an increased probability of receiving training.

11.4.4 The Impact of Training on Current Wages

If workers rarely pay the direct costs of general training, then the competitive model predicts that trainees should receive lower wages. Many studies have looked for evidence of this and it is a fair conclusion to say that little if no evidence for this can be found (see, e.g., Lynch 1992; Barron et al. 1997; Loewenstein and Spletzer 1998). This is an empirical puzzle for the competitive model.

The conventional explanation is that, as the receipt of on-the-job training is positively correlated with measures of human capital (like formal education) and measures of ability (e.g., the aptitude tests used by Altonji and Spletzer 1991), it is quite likely that it is correlated with unobserved ability which, in turn, is positively correlated with wages.

The monopsony model suggests an alternative explanation. As discussed above, we would expect training to be higher in high-wage employers because more of the returns will be internalized. This induces a positive correlation between wages and training. However, the competitive mechanism is still at work: (11.6) shows that, if workers do not pay directly for training, a higher training intensity will be associated with lower wages. This means that the prediction for the empirical correlation is unclear.

11.4.5 *The Impact of Training on Future Wages*

Most (although not all) studies have found that training is associated with increased wage growth. In fact, given the amount of training typically received, the implicit returns to training are often very large compared to the estimated returns to a year of formal education. That training is associated with increased wage growth is in line with the predictions of both the competitive and monopsony models. The two models do differ in terms of their predictions about the returns to general and specific human capital: the competitive model predicts that the returns to general human capital should be larger than the returns to specific human capital while the monopsony model (with some provisos) predicts that the opposite is possible.

The empirical evidence here is mixed. Loewenstein and Spletzer (1999) probably have the best data for distinguishing between general and specific training and do not find evidence of different returns to different types of training. Other studies have more difficulty in distinguishing the type of training but, again, the results are very mixed. Lynch (1992), using earlier data from the NLSY, reports that weeks of off-the-job training and apprenticeships are associated with higher wage growth than weeks of on-the-job training. However, the estimates of Loewenstein and Spletzer (1998) using later data from the NLSY are less clear-cut with the differences in the rate of the return to on- and off-the-job training probably not being significantly different from each other (although one should note that they use incidence as their measure of training not weeks). They do, however, report higher rates of return to off-the-job training with previous employers: this is consistent with the monopsony view as workers may only capture the returns to general training when they change jobs. For the United Kingdom, Blundell et al. (1996) report higher (but probably not significantly higher for men) wage growth for off- than on-the-job training in the current job.

These studies do not provide strong support for Becker's predictions and could potentially be explained using the monopsony model. Given the difficulties, it would be too strong to claim these empirical results as positive evidence in support of a monopsonistic perspective.

11.4.6 *The Impact of Training on Labor Turnover*

A number of papers have investigated the effect of training on labor turnover. As in other areas of research into training, interpretation of correlations is likely to be difficult. For example, Royalty (1996) argues that training is more likely when turnover is lower and looks for evidence of this, but other papers look at the impact of training receipt on turn-

over. Loewenstein and Spletzer (1999) do not find significant differences for the impact of general and specific training on job mobility. Veum (1997), using NLSY data, finds that company-financed training has no significant effect on labor turnover while self-financed training increases labor mobility. For the United Kingdom, Dearden et al. (1997) found that employer-funded training tended to reduce mobility while, in line with Veum (1995), self-funded training tends to increase mobility. Again, it is not clear that the other correlations shed much light on whether the human capital or monopsony model is the better model of training.

11.4.7 The Impact of Training on Productivity

A number of papers have investigated the link between training and productivity although it is obviously difficult to measure the latter. The consensus seems to be that there are large effects on productivity, larger than the effects of wages. Allied to the conclusion that most training is general, this does suggest that employers are getting some of the returns to general training. It is then unsurprising that they pay for it.

11.5 Conclusion

Monopsony power in the labor market leads to significant changes in the conventional wisdom about education and training that is based on Becker's analysis. Perhaps the most important conclusion is that there should be a presumption that there is under-investment in training (particularly general training) as part of the returns to training will be obtained by future employers of workers who are not internalized in the training decision. So, while Becker did discuss how his analysis should be modified if labor markets were not competitive, he gives the impression (without providing a formal analysis) that the provision of training can be efficient whatever the extent of competition in the labor market. But, that conclusion is not really true.

Another important conclusion is that monopsony can help to understand certain empirical anomalies in research on training. First, it is not surprising that we observe many employers paying for their workers to receive general training as their monopsony power means they can expect to reap part (although not all) of the returns. And, it is not surprising that empirical studies fail to find that, ceteris paribus, those workers currently receiving training have lower wages as those employers further up the wage distribution have a greater incentive to train their workers.

Some of Becker's conclusions also need to be modified. For example, monopsony predicts that, in some circumstances, workers will receive a

greater part of the returns (and be asked, directly or indirectly, to pay a greater share of the costs) to specific as compared to general training. The reason is that paying workers with general skills high wages has the disadvantage of forgoing rents on externally recruited workers, rents that cannot be clawed back by paying those workers lower wages when they were unskilled. One must be cautious here: this conclusion is sensitive to the assumption about the range of employment contracts at the disposal of the employer and the empirical evidence on the prediction is not clear-cut.

Hence, monopsony does offer a distinctive and more realistic view about the allocation of the returns to and incentives for training in labor markets, and deserves to be used more widely in this context.

Appendix 11

Proof of Proposition 11.1

By differentiating (11.1), we have

$$\frac{\partial V_i(F)}{\partial F} = \frac{w_i'(F)}{\delta + \lambda[1-F]} \tag{11.20}$$

Integrating the final integral in (11.2) by parts, this equation can be written as

$$\delta_r V_i^u = b + \lambda[V_i(0) - V_i^u] + \lambda \int_0^1 \frac{(1-f)w_i'(f)df}{\delta + \lambda(1-f)} \tag{11.21}$$

Now, from (11.2) and (11.1), we have

$$V_i(0) - V_i^u = \frac{w_i(0) - b}{\delta + \lambda} \tag{11.22}$$

And, using (11.22) and the result from (2.20), integrating the last term in (11.21) by parts, we have

$$\delta_r V_i^u = \frac{\delta b}{\delta + \lambda} + \int_0^1 N(f)w(f)df \tag{11.23}$$

which, using the fact that the employment rate is equal to $\lambda/(\delta + \lambda)$, can be written as (11.3).

Proof of Proposition 11.2

To see the equivalence of the two contracts, consider the following more formal analysis. First, consider the case in which workers are not charged

directly for their training. Suppose that the employer trains unskilled workers at a rate χ. Then the value of being an unskilled worker in the firm, V_0, can be written as

$$\delta_r V_0 = \tilde{w}_0 - \delta_u[V_0 - V_0^u] + \chi(V_1 - V_0) + \lambda \int_{V_0}^{1} [V - V_0]dF_0(V) \tag{11.24}$$

where $F_0(V)$ is the distribution of values on offer to the unskilled in the external labor market and V_1 is the value of being a skilled worker in the firm. Similarly for skilled workers, we have

$$\delta_r V_1 = \tilde{w}_1 - \delta_u[V_1 - V_1^u] + \lambda \int_{V_1}^{1} [V - V_1]dF_1(V) \tag{11.25}$$

Now, profits can be written as

$$\tilde{\pi} = (p_1 - \tilde{w}_1)N_1 + (p_0 - \tilde{w}_0)N_0 - cT \tag{11.26}$$

where N_0 and N_1 are the employment of unskilled and skilled workers, respectively, and T is the level of training. Employment levels will be given by

$$s_0(V_0)N_0 = R_0(V_0) - T \tag{11.27}$$

and

$$s_1(V_1)N_1 = R_1(V_1) + T \tag{11.28}$$

where s and R are the separation and recruitment rates. Finally, we have the equation

$$\chi = \frac{T}{N_0} \tag{11.29}$$

for the training intensity.

This is quite a lot of equations but inspection of (11.24) should make it clear that an increase in the training intensity, χ, allows the employer to cut the unskilled wage while still maintaining the value of an unskilled worker in the firm. In this sense, workers do bear part of the cost of training. But, quite how much is not immediately obvious from the above equations.

Now, imagine that the employer moves from the contract in which workers are not charged directly for training to one in which they are. The amount that can be charged to workers is the gain to them from becoming skilled which is given by $V_1 - V_0$. Further, imagine that, in making this change, the employer does not want to alter the value of being an unskilled or skilled worker in the firm. As unskilled workers no longer have a capital gain on becoming skilled, (11.24) implies that the

wage that is now paid to unskilled workers, w_0, must be given by

$$w_0 = \tilde{w}_0 + \chi(V_1 - V_0) \tag{11.30}$$

while the skilled wage must be unchanged. With this change and with the fact that it now costs employers $c - (V_1 - V_0)$ whenever workers are trained, employers will make the following level of profits in the new contract:

$$\begin{aligned}\pi &= (p_1 - w_1)N_1 + (p_0 - w_0)N_0 - [c - (V_1 - V_0)]T \\ &= (p_1 - \tilde{w}_1)N_1 + (p_0 - \tilde{w}_0)N_0 - \chi(V_1 - V_0)N_0 - [c - (V_1 - V_0)]T \\ &= \tilde{\pi}\end{aligned} \tag{11.31}$$

where the last inequality follows from the use of (11.29). (11.31) says that the employer will make exactly the same level of profit.

(11.6) comes directly from (11.30), and (11.7) and (11.8) from (11.24) and (11.25) with the modification that unskilled workers make no capital gain when trained when they are charged directly.

Proof of Proposition 11.3

By differentiating (11.12) with respect to w_0 we obtain the first-order condition

$$(p_0 - w_0)\frac{\partial N_0}{\partial w_0} - N_0 - \frac{\partial V_0}{\partial w_0}T = 0 \tag{11.32}$$

Now, from (11.7), $(\partial V_i/\partial w_i) = 1/s_i(w_i)$ so that, using (11.10), (11.32) can be re-arranged to give

$$(p_0 - w_0)s_0\frac{\partial N_0}{\partial w_0} = R_0 \tag{11.33}$$

Now, by differentiating (11.10), we have

$$s_0\frac{\partial N_0}{\partial w_0} = \frac{\partial R_0}{\partial w_0} - \frac{\partial s_0}{\partial w_0}\frac{R_0 - T}{s_0} \tag{11.34}$$

Using (11.34) in (11.33) leads to (11.13).

For skilled workers, by differentiating (11.12) with respect to w_1 we obtain the first-order condition

$$(p_1 - w_1)\frac{\partial N_1}{\partial w_1} - N_1 + \frac{\partial V_1}{\partial w_1}T = 0 \tag{11.35}$$

Now, from (11.7), $(\partial V_i/\partial w_i) = 1/s_i(w_i)$ so that, using (11.11), (11.35) can be re-arranged to give

$$(p_1 - w_1)s_1 \frac{\partial N_1}{\partial w_1} = R_1 \tag{11.36}$$

Now, by differentiating (11.11), we have

$$s_1 \frac{\partial N_1}{\partial w_1} = \frac{\partial R_1}{\partial w_1} - \frac{\partial s_1}{\partial w_1} \frac{R_1 + T}{s_1} \tag{11.37}$$

Using (11.37) in (11.36) leads to (11.15).

The first-order condition for training, (11.17) follows straightforwardly from differentiation of (11.12) with respect to T.

Part Four

WAGE-SETTING INSTITUTIONS AND CONCLUSIONS

12

The Minimum Wage and Trade Unions

Previous chapters have assumed that employers can freely choose wages. Of course, the choice of the wage will be influenced by what is happening in the rest of the labor market but there are no external constraints on the wage that can be chosen. However, there are often restrictions on the wages that employers can pay and this chapter is about two of these constraints: the minimum wage and trade unions.

The textbook competitive analyses of minimum wages and trade unions are very similar, if not identical. Both institutions are seen as raising wages above the market-clearing level, reducing employment in the affected sectors. But, in oligopsonistic labor markets, minimum wages and trade unions are unlikely to have the same effect. If labor markets have substantial wage dispersion (and both theory and evidence suggest that they do), then minimum wages are likely to "push" the wage distribution from below as, by definition, they directly affect the lowest wages in the market while (in a given labor market) trade unions are likely to "pull" the wage distribution from the top as the existence of a union wage premium strongly suggests that they are the highest wage firms. Hence, the analysis of the two institutions is likely to be rather different.

This chapter discusses the two main issues that have concerned economists:

- what is the impact of minimum wages/trade unions on the distribution of wages?
- what is the impact of minimum wages/trade unions on employment?

The plan of the chapter is as follows. The next two sections consider the impact of minimum wages on the distribution of wages and the following section, the impact on employment. The third and fourth sections then consider the impact of trade unions on wages and employment.

12.1 The Minimum Wage and the Distribution of Wages: Spikes and Spillovers

The most noticeable impact of the minimum wage on the distribution of wages is the existence of a "spike" in the wage distribution at the legis-

lated minimum. Of course, the height of the spike depends on the level at which the minimum wage is set but it is generally there. For example, in September 1997 the United States raised the federal minimum wage from \$4.75 an hour to \$5.15. The percentage of hourly paid workers (in the CPS monthly outgoing rotation group) reporting an hourly wage of *exactly* \$4.75 went from 1.3% in August 1997 to 0.2% in September. The percentage paid exactly \$5.15 was 0.3% in August rising to 1.9% in September. The minimum wage is not the only wage at which we observe spikes: they are also observed at "round" numbers but it is the spike that is probably most amenable to economic explanation.

The existence of a spike is sometimes regarded as something of a "puzzle" both for competitive and monopsony models of the labor market. But, this is not the case for either model. In the competitive model, the "puzzle" arises because labor economists often have in mind a model in which the marginal product of a worker is exogenously given. If this were the case, then a minimum wage would simply truncate the wage distribution at the minimum as all those previously paid below it would lose their jobs. There would be truncation, but there would be no spike. This model is a simple one and convenient to work with, but there is no particular reason to believe it to be true and plausible generalizations can readily explain the existence of a spike.

For example, suppose that marginal revenue product depends on the level of employment either because of decreasing returns in production or because falling employment in a sector may cause the price of the product produced to rise. Then, if the aggregate labor market consists of a number of distinct segments (perhaps differentiated by skill), a fraction of segments will have a wage equal to the minimum and this will be the cause of the spike. Alternatively, if there are non-pecuniary aspects to jobs (call them effort), then one would expect employers to raise effort in response, to a minimum wage and the result again will be a spike (although it is probably fair to say that no evidence for these off-setting effects has ever been produced). This argument for the spike might also be thought to apply in the monopsony model.[1]

For the monopsony model, the source of the "puzzle" of the spike is the simple general equilibrium model of oligopsony described in section 2.4, the model of Burdett and Mortensen (1998). For reasons discussed in that section, the equilibrium wage distribution can have no mass points

[1] It is sometimes argued that the minimum wage is fatally flawed because it does not control these non-wage benefits and, as a result, minimum wage workers will actually be made worse off by the minimum wage as their employers are forced to offer an inefficient wage–effort combination. But, as Proposition 8.1 in section 8.4 showed, we would expect workers in a monopsonistic labor market to be made better off by a binding minimum wage even if employers can freely vary non-wage aspects of the job. This is consistent with the evidence found in Holzer et al. (1991).

because it would then pay employers to deviate by paying an infinitesimally higher wage. This result applies equally to the free market equilibrium and to the model with a binding minimum wage. In this model, a minimum wage affects the wage distribution by raising and compressing wages but there is no spike. Van den Berg (1999) makes this a virtue of the model arguing that there are labor markets in which there is no spike yet the minimum wage does have an impact on the wage distribution. However, it seems likely that the situations in which a binding minimum wage has no apparent spike are either the result of using earnings measures with substantial measurement error or institutional set-ups in which wages are marked up on the minimum wage, for example, by unions. Evidence for the first of these effects can be seen in the United Kingdom. The traditional way in which hourly earnings are measured is to divide weekly earnings by weekly hours. No, or a very small spike is apparent using this data: for example, the fraction of hourly paid workers in the UK Labour Force Survey (LFS) reporting being paid exactly the national minimum wage of £3.60 per hour from April to December 1999 was 1.4%. But, in Spring 1999 a direct hourly wage question was introduced and this does shows a much larger spike: the same sample of workers shows a spike of 9.4% using this measure.

The Burdett–Mortensen model of monopsony is unable to explain the spike because, as discussed in section 2.4, there is a discontinuity in the labor supply function facing each firm at every wage that is paid by a mass of firms. But real world labor supply curves are unlikely to exhibit such discontinuities (e.g., because of heterogeneity in the evaluation of non-wage attributes of jobs or mobility costs) and, if the labor supply curve is continuous, one can readily explain the spike at the minimum wage. To see this, suppose that the labor supply curve facing a firm is $N(w)$ where w is the wage paid: assume this to be a continuous function of w. Then, an employer will want to solve the maximization problem:

$$\max_{w} (p - w)N(w) \qquad \text{s.t.} \qquad w \geq w_m \tag{12.1}$$

where w_m is the minimum wage. If there is heterogeneity in p across firms, the constraint will be binding for low values of p and the result will be a spike in the wage distribution.

Hence, one should not be surprised by, or particularly interested in, the existence of a spike in the wage distribution at the minimum wage except in so far as it gives some indication of how much "bite" the minimum wage actually has. But, while the spike is the most striking evidence of the impact of a minimum wage on the wage distribution, it may be that the minimum wage also has an effect on wages further up the wage distribution: what are known as spillovers.

Providing a theoretical model in which there are spillovers is not difficult. The Burdett–Mortensen model predicts that a binding minimum wage affects wages at every point in the wage distribution although the effect is weaker as one moves up the percentiles.[2] But, this theoretical model does not make it very clear why we might expect spillovers.

From the simple model in (12.1) it is not immediately obvious why spillovers would exist. A simple-minded approach to the analysis of (12.1) would conclude that the only effect of the minimum wage on the wage chosen by an employer will be if it is a binding constraint but that an employer who pays strictly above the minimum will be unaffected by changes in it, that is, there will be no spillovers. Another way to put this is to say that there can only be spillovers to the extent that the minimum wage affects the productivity of workers (p) or the labor supply curve $N(w)$.

An effect on productivity is most likely to occur if there are changes in employment as a result of the minimum wage that affect the output of the product and hence, through an industry demand curve, the price. Such an effect is likely to be similar at all points in the wage distribution: the evidence presented below is very much against this.

So, the most likely route for spillovers is through the labor supply curve to an employer. Why might $N(w)$ depend on the minimum wage? Consider an employer who initially pays just above what is going to be the minimum wage. When a minimum wage is introduced, the gap narrows between this employer's wage and the wages paid by lower-wage employers. As a result it is less likely that workers in those employers will come to work for this one if they get a job offer and more likely that this firm's workers leave to go to work in those firms (although they will still be taking a wage cut, it is smaller than before). Hence, the labor supply to this employer is likely to fall. As one moves up the wage distribution, the impact of what happens in minimum wage employers is likely to have less and less impact on an employer. Hence, the minimum wage will reduce labor supply to employers who pay above the minimum wage but proportionately more in low wage employers. In mathematical terms this can be written as

$$\frac{\partial^2 \log N(w, w_{\mathrm{m}})}{\partial \log w_{\mathrm{m}} \partial \log w} > 0 \qquad (12.2)$$

[2] It is possible to construct theoretical models in which the minimum wage can reduce wages at some percentiles. Fershtman and Fishman (1994) present a model in which the search intensity of workers is endogenous. As the minimum wage rises, the wage distribution becomes compressed and the incentives for on-the-job search are reduced. But it is this on-the-job search which determines the intensity of competition among employers for workers so that wages at the top of the distribution may be reduced.

This implies that an increase in the minimum wage increases the elasticity of the labor supply curve facing an employer: this, through the usual mechanism in monopsony, leads them to choose higher wages. But, it is likely that this change in the elasticity is smaller in higher-wage firms as they are less influenced by the minimum wage so this effect declines as wages increase. Hence, there will be spillover effects that decline as one moves up the wage distribution.

There are other reasons why the minimum wage may affect the supply of labor to firms who pay above the minimum wage. The minimum wage is likely to affect incentives for job search. Those in low-wage jobs are likely to have less incentive to look for alternative jobs than before as the wage gap between this job and their current one is reduced (see (9.5)). For those out of work, there are likely to be two effects at work. First, higher wages in work increase the incentives to seek work. Secondly, the minimum wage may affect the arrival rate of job offers: this will again have an effect on search intensity.

How large are spillover effects in practice? The evidence on this is surprisingly small. Perhaps that is primarily because the consensus view is that the minimum wage has little effect on the wage distribution in the United States. But, a small number of papers (diNardo et al. 1996; Lee 1999; Teulings 2000) have challenged this view arguing that the minimum wage has a more substantial impact on the wage distribution than previously thought.

Both Lee (1999) and Teulings (2000) estimate the spillover effect although it is not the main focus of their papers. The approach in Teulings (2000) is based on a competitive model of the labor market in which technology is assumed to have the realistic but messy feature of a "decreasing in distance elasticity of substitution" between workers with different skill levels. Lee (1999) takes a less structural approach and this is the one we use here. He assumes that, in the absence of the minimum wage, the log wage at position F in the wage distribution is given by $w^*(F)$: call this the latent wage distribution. With the introduction of a minimum wage, w_m, the actual wage distribution, $w(F)$, will differ from the latent wage distribution. For example, if there are no spillover effects and the minimum wage is fully enforced, then the wage distribution will be given by

$$w(F) = w^*(F) + \max(w_m - w^*(F), 0) \qquad (12.3)$$

Lee (1999) generalizes this and proposes the following model that allows for spillover effects:

$$w(F) = w^*(F) + \frac{w_m - w^*(F)}{1 - \exp[-\beta(w_m - w^*(F))]} \qquad (12.4)$$

where $\beta > 0$ is a parameter which measures the size of the spillover effect. If $\beta = \infty$, the model of (12.4) reduces to that of (12.3) so that an increase in β is a reduction in the spillover effect. The spillover effect, $s(F)$, can be written as

$$s(F) = \frac{w_m - w^*(F)}{1 - \exp[-\beta(w_m - w^*(F))]} - \max(w_m - w^*(F), 0) \qquad (12.5)$$

that is, it is the difference between the total effect $[w(F) - w^*(F)]$ and the direct effect as measured by the final term in (12.3). Inspection of (12.5) shows that the spillover effects in the Lee model depend only on the gap between the minimum wage and the latent wage and the single parameter β. There are several implications of the particular model of spillovers in (12.5). The spillover effects are largest for those just affected by the minimum wage (i.e., those for whom $w_m = w^*(F)$) and, for these workers, the increase in log wages is equal to $(1/\beta)$. Secondly, the spillover effects decline as one moves away from these wages, the rate of decline also being determined by β.

In a more general model of spillovers, one might think of estimating:

- the wage at which the spillover effect is greatest;
- the maximum spillover effect;
- how wide are the spillover effects;

that is, a three parameter model instead of the single parameter model estimated by Lee (1999). However, as shown below, the Lee model does surprisingly well in estimating the spillover effects for the US aggregate wage distribution.

To estimate the model, one has to make some assumption about the latent wage distribution $w^*(F)$. We make the simple assumption that the latent log wage distribution is normal, that is,

$$w^*(F) = w_{med} + \sigma\Phi^{-1}(F) \qquad (12.6)$$

where w_{med} is the log of the median wage and $\Phi^{-1}(F)$ is the inverse of the standard normal distribution function.

Table 12.1 presents some estimates of the Lee model estimated by non-linear least squares on US data from 1979 to 2000 inclusive. The model in (12.4) is fitted to all percentiles below the median where each observation is a percentile of the log hourly wage distribution in a particular state in a particular "year." Because the minimum wage is not always raised on January 1, Lee's practice of defining "year" loosely as a period of approximately a year in which the minimum wage is constant is followed here: details of the observations affected by this are given in the notes to the table. Some percentiles are below the federal minimum wage: these were simply excluded from the analysis.

TABLE 12.1
Spillover Effects of Minimum Wages on the US Wage Distribution

	Sample Period	β	σ
1	1979–2000	8.88 (0.05)	0.623 (0.001)
2	1979–84	9.44 (0.07)	0.645 (0.001)
3	1985–90	8.67 (0.10)	0.632 (0.001)
4	1990–94	8.31 (0.09)	0.625 (0.001)
5	1995–2000	6.60 (0.07)	0.633 (0.002)

Notes.

1. These are the results of the model of (12.4) and (12.6) being fitted by non-linear least squares to observations on percentile-state-year combinations. Only observations below the median are used. The sample size for the entire period is 55,200 and the $R^2 = 0.99$.
2. The maximum of the federal and state minimum wage is used. As the minimum wage is not always changed on January 1, the following deviations from calendar years were used for years in which the federal minimum was not changed at the beginning of the year: 1989 includes January–March 1990; 1990 includes January–March 1991; 1997 includes October–December 1996; and 1998 includes September–December 1997. In addition, the following state changes override other changes: for California 1987 includes until June 1988, there are "extra" years for October 1996 to February 1997 and October 1997 to February 1998; for Connecticut 1988 and 1989 include October–December 1987 and 1988, respectively, and 1990 includes January–March 1991; for Delaware 1995 includes January–March 1996, and 1998 includes September–December 1997 and January–April 1999; for Hawaii 1990 and 1991 include January–March 1991 and 1992, respectively; for Massachusetts 1987 and 1988 include July–December 1986 and 1987, respectively; for New Jersey, 1991 includes January–March 1992; for Rhode Island the years 1985–88, 1992–95, and 1999 include January–June of the following year, 1989 includes January–April 1990, 1990 includes January–March 1991, 1995 includes January–August 1996, and 1998 includes January–June 1999; for Vermont the years 1985–88 include January–June of the following year, 1989 and 1990 include January–March of the following year, and 1998 and 2000 include October–December of the preceding year; for Washington, 1990 includes January–March 1991, 1998 includes September–December 1997, and 2000 includes December 1999; for Wisconsin, 1988 includes January–June 1989, 1989 includes January–March 1990.

The first row of table 12.1 pools all the observations for the entire 22-year period. The underlying standard deviation of log wages is estimated to be 0.6 and the spillover parameter β is 8.8 which implies that the maximum size of the spillover effect is 0.11 log points.

Given the large literature on rising inequality in the United States, one might be concerned about assuming the underlying variance of wages is constant. The next four rows estimate the model for different sub-samples. As was the conclusion in Lee's paper, there is no evidence here of rising underlying wage inequality: rather, all of the observed variation in wage inequality at the bottom end of the wage distribution can be accounted for by variations in the level of the minimum wage (see

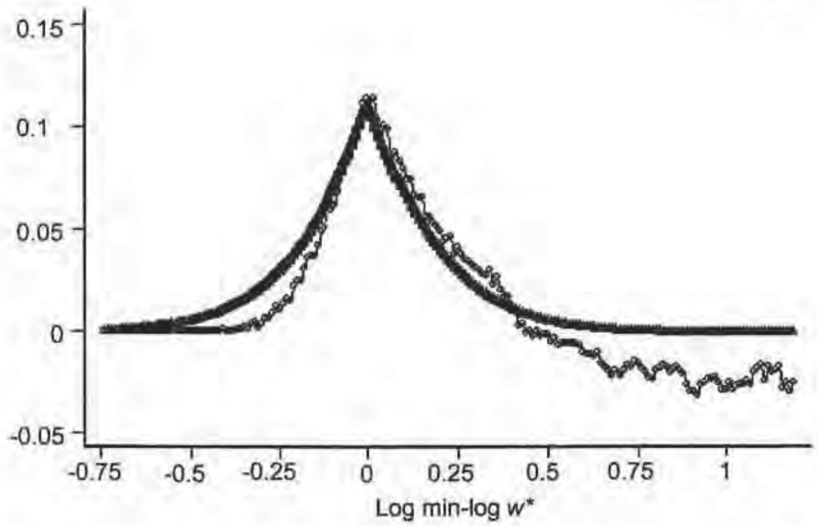

Figure 12.1 Actual and predicted spillover effects of the minimum wage. ○, actual spillover; Δ, predicted spillover.

the next section for further discussion of this). Ironically, there seems to be more evidence of a trend in the spillover effect than in the underlying wage inequality.

To give some idea of how well the model fits the data, figure 12.1 plots the actual and predicted spillover effects against the gap between the minimum wage and the latent wage. (12.5) makes it clear that the predicted spillover effect depends only on this gap and this formula is used to compute the prediction. The actual spillover effect for each observation, s_a, is measured by

$$s_a = w - \max(w_m, w^*) \qquad (12.7)$$

that is, the difference between the actual wage and the predicted direct effect. This actual spillover effect is then averaged over values of the gap between the minimum wage and the latent wage. Note that both the actual and predicted spillover effects are estimated conditional on the value of σ reported in table 12.1.

As can be seen from figure 12.1, the model does a good job in explaining the data. The spillover does peak where the minimum equals the latent wage and decays on either side of this. There are some ways in which the model could probably be changed to fit the data even better. There is some evidence that the spillover effect for those whose latent wage is just below the minimum is over-estimated and also, perhaps, that the wages of those further up the wage distribution actually decline. But,

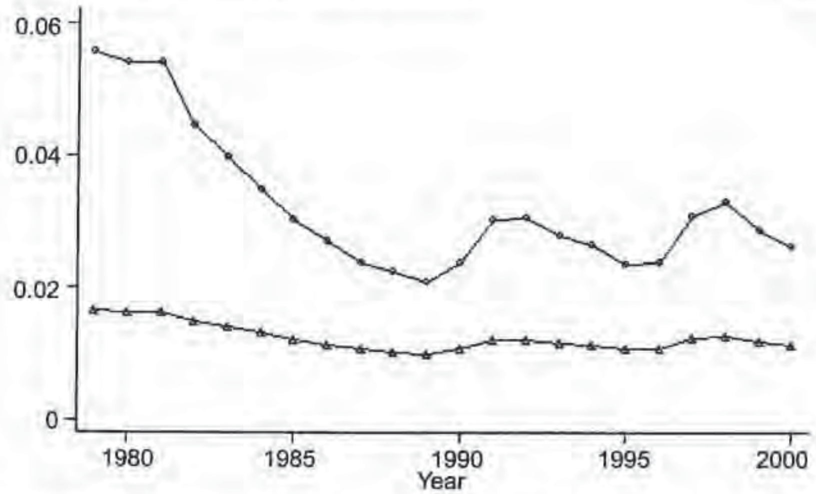

Figure 12.2 The direct and indirect effect of the US minimum wage on average wages. ○, direct effect; △, spillover effect.
Note: These use the parameter estimates from row 1 of table 12.1. The left-hand axis is the percentage increase in the average wage.

the actual deviation between predicted and observed is relatively small and these nuances are left for development elsewhere.

How big are the spillover effects? One way of getting some idea of this is to compare the implied direct and spillover effect on total mean log wages for the US economy. As this varies with the level of the minimum wage, a time series is plotted in figure 12.2. The direct impact varies a lot over time with the level of the minimum wage, being high at the beginning of the sample period and then declining through the 1980s only to increase slightly in the 1990s. In contrast, the estimated spillover effect is relatively constant implying that it raises wages by about 1.7%.

Figure 12.2 provides estimates of the impact of the minimum wage on the average level of wages. But, one might also be interested in the impact on the distribution of wages. The conventional wisdom is that the US minimum wage has a rather small impact on the overall wage distribution but, as the following section makes clear, one can make a strong case that the minimum wage is far more important than that.

12.2 The Minimum Wage and Changes in US Wage Inequality

There is an enormous literature on the evolution of US wage inequality over the past three decades (for a recent survey, see Katz and Autor 1999).

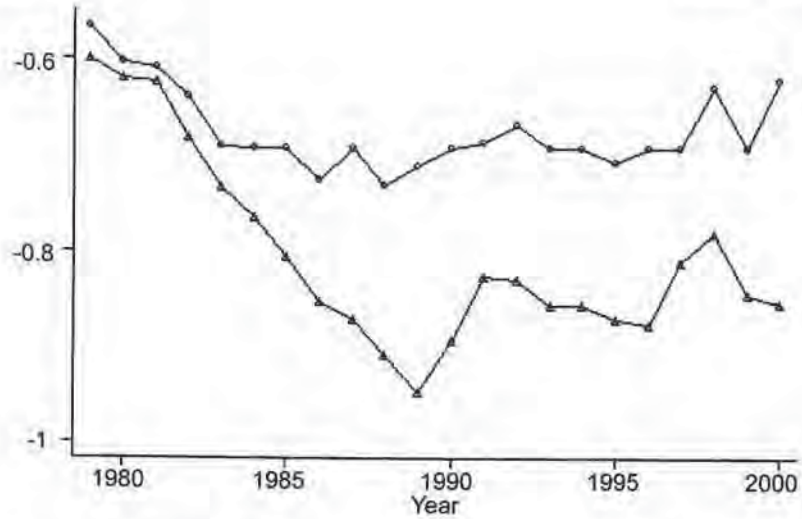

Figure 12.3 The evolution of US wage inequality and the minimum wage, 1979–2000. O, log 10–50 differential; Δ, log Kaitz index.

Notes. Data are from the CPS monthly outgoing rotation groups. The log Kaitz index is computed as the log of the federal minimum divided by the median wage.

The consensus view is that the increase in wage inequality is the result of technological progress that is biased in favor of skilled workers and that the increase in the supply of skilled workers has failed to match the increase in demand. The purpose of this section is to argue that the evidence for a strong underlying rise in wage inequality at the bottom (but not the top) end of the distribution is much weaker than might be thought given this literature and that what changes there have been can be ascribed in large part to changes in the minimum wage.

First, start with the trends in wage inequality in the United States that are so often discussed. As the minimum wage only affects the bottom end of the wage distribution, we do not consider what has been happening above the median. Figure 12.3 plots the log 10–50 wage differential from the CPS monthly outgoing rotation groups against the log of the ratio of the federal minimum wage to the median wage, the log of the Kaitz index. The most striking episode is the dramatic fall in the log 10–50 differential in the 1980s. But, it is important to realize that this trend has not continued in the 1990s: wage inequality at the bottom end has been in slight decline. This broadly mirrors changes in the Kaitz index. The Kaitz index fell dramatically in the 1980s as the federal minimum was constant in nominal terms; since then the general trend has been upwards although this trend comprises a few large changes between which the real value of

the minimum wage is eroded by inflation. Figure 12.3 suggests there may be some link between the minimum wage and the evolution of wage inequality in the bottom half of the US wage distribution. However, the apparent close correlation between the two series in figure 12.3 may be the result of the presence of the median wage in both series so better evidence is needed.

To try to allay some of these fears, table 12.2 presents some regressions. From the CPS monthly outgoing rotation groups we constructed percentiles of the wage distribution by month for each state for the period January 1979 to December 2000. We are interested in how changes in log wages at different percentiles respond to changes in the minimum wage. Of course, the minimum wage is fixed in nominal terms but we would like some real measure of the impact of the minimum wage: consequently we measure the impact of the minimum wage as the log of the Kaitz index for the whole economy. The regressions take the form

$$\Delta\log(w_F)_{st} = \beta[\Delta\log(w_{\min})_{st} - \Delta\log(w_{50})_t] + \text{state dummies} + \text{year dummies} + \text{month dummies} \tag{12.8}$$

where $\Delta\log(w_F)_{st}$ is the monthly change in the log wage at the Fth percentile in state s at time t (which is monthly). To avoid the problems caused by the monthly sampling variation in the median wage, the change in the Kaitz index is instrumented by the change in the minimum wage. These regressions are similar in spirit although different in detail from those in Lee (1999) who used annual data and whose sample ended in 1989. It should be emphasized that estimating equations of the form of (12.8) is quite a tough test for the impact of the minimum wage: we are looking for extra wage growth in months where the minimum wage changes.

The results from this equation are presented in Panel A in table 12.2. The first row shows a significant impact of the change in the minimum wage on the 10th percentile with an elasticity of 0.146, a smaller effect on the 25th percentile that is on the margins of statistical significance and insignificant (although negative) effects on other percentiles. How much of the changes in wage inequality can be explained using this simple regression? The answer, for the bottom end of the wage distribution is more than everything that actually occurred. Figure 12.4 plots the year effects from the regression in (12.8) for the 25th, 50th, 75th, and 90th percentiles relative to the 10th percentile. These can be thought of as giving an estimate of the evolution of wage inequality if the minimum wage had been continuously adjusted to keep the Kaitz index constant. The fall in the underlying log 50–10 wage differential says that there is an

TABLE 12.2
The Impact of the Minimum Wage on the US Wage Distribution

	(1) *10th Percentile*	*(2)* *25th Percentile*	*(3)* *50th Percentile*	*(4)* *75th Percentile*	*(5)* *90th Percentile*
A.					
Change in log Kaitz index	0.146	0.074	−0.060	−0.051	−0.106
	(0.045)	(0.051)	(0.048)	(0.052)	(0.061)
Observations	13110	13110	13110	13110	13110
R^2			0.12	0.06	0.07
B.					
Change in log Kaitz index	0.330	0.241	0.107	0.000	0.110
	(0.100)	(0.115)	(0.110)	(0.116)	(0.137)
Change in log Kaitz	−0.408	−0.372	−0.370	−0.113	−0.481
index × wage rank	(0.190)	(0.218)	(0.208)	(0.221)	(0.260)
Observations	13110	13110	13110	13110	13110
R^2	0.10	0.09	0.08	0.05	0.05

Notes.

1. The individual observations are from state–month cells for the period 1979–2000 inclusive. Year, month, and state dummies are also included but are not reported. The change in the log of the Kaitz index is instrumented by the change in the log of the minimum wage, and the change in the log of the Kaitz index times the wage rank is instrumented by the change in the log of the minimum wage times the wage rank.
2. Standard errors are in parentheses.

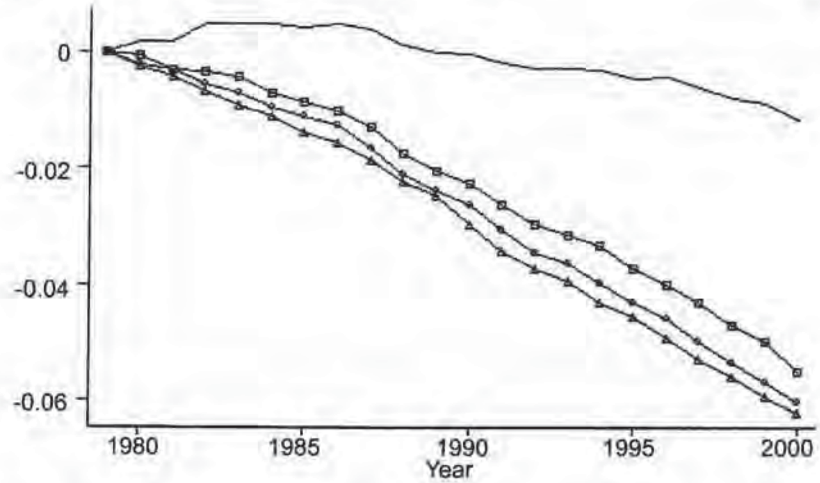

Figure 12.4 The underlying trends in US wage inequality, 1979–2000. ○, underlying change in log 50–10; △, underlying change in log 25–10; □, underlying change in log 75–10; solid line, underlying change in log 90–10. *Notes*. The underlying change in measures of wage inequality represented in this graph come from the year dummies estimated from the models in the top half of table 12.2.

underlying trend in the economy towards reduction in this measure of wage inequality. As one can see, the results are the same for all the measures of wage inequality except the log 90–10 which is predicted to have been approximately constant.

One can go further in demonstrating the importance of the minimum wage. We would expect the impact of the minimum wage to be larger on those groups with lower wages, for example, we would expect the effect to be stronger in low-wage than high-wage states. The regressions in Panel B of table 12.2 investigate this by including as an extra regressor in (12.8), the average wage in the state in 1989 (measured on a scale from 0 to 1 where 0 is the lowest-wage state and 1 the highest) interacted with the change in the Kaitz index. We would expect this to have a negative sign as the minimum wage will have less impact in high-wage states. This is, indeed, what we find.

This section has argued that changes in the minimum wage have had a demonstrable and large effect on US wage inequality which is too often neglected. These points have been made before (diNardo et al. 1996; Lee 1999; Teulings 2000) and the evidence presented here adds to that presented in those papers—that the evolution of the minimum wage is of first-order importance in understanding trends in equality in the bottom half of the US wage distribution.

This section has shown how the minimum wage affects the wage distribution. The next section considers the impact on employment, an issue that has generated enormous controversy.

12.3 The Minimum Wage and Employment

Perhaps the most controversial aspect of the economics of the minimum wage is its effect on employment. The competitive model has the unambiguous prediction that employment should fall if a binding minimum wages is introduced or raised. There is an enormous empirical literature that seeks to provide estimates of the employment effect and there is little point in reviewing all the studies here (for a relatively recent review, see Brown 1999). Prior to the early 1990s, something of a consensus had been established about the impact of minimum wages on employment in the United States, namely that, while the minimum wage had no effect on the employment of adults (because it was set so low), it did have a modest but significantly negative effect on the employment rate of teenagers. This view was powerfully challenged by Card and Krueger (1995) who, in a series of studies, concluded that there was no evidence of a negative employment effect from the minimum wage. Perhaps their most celebrated study (Card and Krueger 1994) was the comparison of employment changes in fast food restaurants in New Jersey and eastern Pennsylvania when New Jersey raised its minimum wage above the federal minimum in April 1992. The debate about these claims was, at times, acrimonious primarily because the 1990s was a time in which the raising of the minimum wage was an active political issue. It has rumbled on for the best part of a decade: see Card and Krueger (2000) and Neumark and Wascher (2000) for the latest installments in the debate about the New Jersey study (with Card and Krueger coming off better).

Many labor economists have had problems in even conceiving of the possibility that the minimum wage does not destroy jobs, even likening (apparently with a straight face) the Card–Krueger and other similar findings to a reversal of the laws of gravity. But, if labor markets are monopsonistic, one should not really be surprised by or skeptical of such findings as it is well-known that minimum wages do not necessarily reduce employment under monopsony. Indeed, textbooks often only discuss monopsony in the context of this "contrary" prediction about the impact of the minimum wage.

In the textbook model of a single monopsonist, the relationship between employment and the minimum wage looks something like that drawn in figure 12.5. Employment is maximized by choosing a minimum

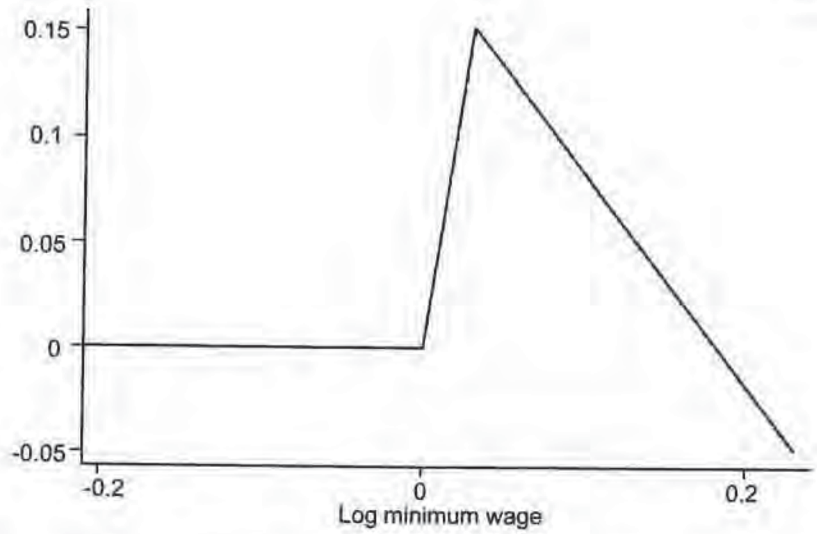

Figure 12.5 The relationship between employment and the minimum wage: the single monopsonist.

Notes. The vertical axis is the change in log employment from the free market level. The log minimum wage is measured as a deviation from the free market log wage. The parameters used are an elasticity of the labor supply curve facing the employer of five and an elasticity of the marginal revenue product curve of one.

wage that is the market-clearing level which, if the elasticity of the labor supply curve facing the employer is $(1/\varepsilon)$ and the elasticity of the marginal revenue product of labor curve is $(1/\eta)$, implies a rise of $\varepsilon \ln(1 + \varepsilon)/(\varepsilon + \eta)$ in the log wage with an associated log employment gain of $\ln(1 + \varepsilon)/(\varepsilon + \eta)$. In this textbook model of monopsony there is always some appropriately chosen minimum wage that can raise employment and the scope for minimum wages to do this is determined by the monopsony power of employers (as measured by the elasticity of the labor supply curve facing them). But, these conclusions are based on a partial equilibrium model of a single monopsonist and it is important to consider the extent to which they remain true in a general equilibrium model as the minimum wage is never a policy that affects a single employer.

There are two important distinctions between partial equilibrium models of monopsony and general equilibrium models of oligopsony. First, in general equilibrium, there is an important distinction between the elasticity of labor supply to the market as a whole and to individual employers. While the gap between the marginal product and the wage is determined by the elasticity of the labor supply curve facing an individual employer, any aggregate employment effect will be determined by the

elasticity of the labor supply curve to the labor market as a whole. There is no reason why these should be the same but it is exactly that assumption that is made by the model of a single monopsonist.

Secondly, it is important to take account of heterogeneity. There is no doubt that the minimum wage is a blunt instrument, applied across whole labor markets on employers who would otherwise choose very different wages. This means that it is almost certainly the case that the minimum wage will have different effects on employment in different employers and any measure of the impact on aggregate employment must take account of this heterogeneity.

To consider these issues, we will use a model based on that used by Dickens et al. (1999) and similar to that used in the discussion of the employer size–wage effect in section 4.1. Assume firm i has a log marginal revenue product of labor curve given by

$$\mathrm{mrpl}_i = a_i - \eta n_i \tag{12.9}$$

where n is log employment and a is a shock to the MRPL that reflects demand or productivity shocks. If the labor market is perfectly competitive then the elasticity of the labor demand curve would be $(1/\eta)$.

Turning to the labor supply curve to the firm, we will use a very simple model. Analogous to the Dixit and Stiglitz (1977) model of imperfectly competitive product demand curves, assume that the share of total employment, N, going to employer i, N_i, is given by its wage, W_i, relative to an average wage index W and an employer-specific shock, B_i,[3] according to the following function:

$$\frac{N_i}{N} = \left(\frac{W_i}{B_i W}\right)^{1/\varepsilon} \tag{12.10}$$

Also, assume that the labor supply to the whole market, is given by the following function:

$$N = N_0 W^{\phi} \tag{12.11}$$

so that an increase in the average wage encourages more workers to enter the labor market. Combining (12.10) and (12.11), taking logs, and denoting logs of variables by lower case, we can write the labor supply curve facing the individual employer as

$$w_i = (1 - \varepsilon\phi)w + \varepsilon(n_i - n_0) + b_i \tag{12.12}$$

[3] B_i is a firm specific labor supply shock that could represent differences in the non-pecuniary attractiveness of work in different firms. An alternative, more general interpretation, is that it represents differences in the wages paid in different firms necessary to prevent shirking or differences in the bargaining power of workers in different firms. It is the existence of this shock that ensures that the model generates a distribution of wages even if the labor market is perfectly competitive.

If the labor market is perfectly competitive then $\varepsilon = 0$ but if $\varepsilon > 0$ the market is, to some extent, monopsonistic. Note that the impact of the average wage on the labor supply curve to an individual employer is ambiguous in sign as there are two effects. On the one hand, a higher average wage means any individual employer needs to pay a higher wage to get the same fraction of employment as before. On the other hand, a higher average wage means that the overall supply of labor to the market increases which has the opposite effect. Note that in the model of (12.12) the only route for the minimum wage to affect the labor supply curve to individual employers is through the average wage and the effect will be the same for all employers.[4]

For future use, let us rewrite (12.12) by subsuming n_0 into b_i and writing the coefficient on the average wage as θ. (12.12) then becomes

$$w_i = \theta w + \varepsilon n_i + b_i \tag{12.13}$$

To keep the mathematics simple, assume w is the average log wage across firms.

First, consider the equilibrium when there are no minimum wages. Each firm chooses the level of employment where the log MRPL equals the log marginal cost of labor which, from (12.13) is given by

$$\text{mcl}_i = \ln(1+\varepsilon) + w_i = \ln(1+\varepsilon) + \theta w + \varepsilon n_i + b_i \tag{12.14}$$

Equating (12.14) and (12.9) gives employment in firm i as

$$n_i = \frac{-\theta w - \ln(1+\varepsilon) + a_i - b_i}{\eta + \varepsilon} \equiv n(w, a_i, b_i) \tag{12.15}$$

and from (12.13) the wage is

$$w_i = \frac{\eta\theta w - \varepsilon \ln(1+\varepsilon) + \varepsilon a_i + \eta b_i}{\eta + \varepsilon} \tag{12.16}$$

(12.15) and (12.16) are easy to understand. Revenue shocks, a, have a positive effect on employment while supply shocks, b, have a negative effect. In contrast, both a and b are positively related to wages although, as we would expect, a only has an effect to the extent that the labor market is not perfectly competitive (where $\varepsilon > 0$)—these are the correlations between wages and employer characteristics described in chapter 8. For future use, define v_i by

$$v_i = \frac{\varepsilon a_i + \eta b_i}{\eta + \varepsilon} \tag{12.17}$$

[4] This goes against the evidence on spillovers presented in the previous section: one could make the elasticity depend on the minimum wage but this would complicate the model without altering the basic points that will be made.

If a_i and b_i are jointly normally distributed (the most convenient assumption for what follows), then will have a normal distribution v_i. For future use denote the variance of v_i by σ_w where the notation reflects the fact that, from (12.16), this will be the variance of log wages in the absence of the minimum wage.

One can then solve the model by taking expectations of (12.16) and using the assumption that $E(w_i) = w$. Normalize so that $E(a_i) = E(b_i) = 0$: this means that in a competitive equilibrium w and n will be zero. So all the derived equilibrium expressions for w and n derived below should be thought of as log deviations from the competitive equilibrium. The free market equilibrium level of wages is given by

$$w = \frac{-\varepsilon \ln(1+\varepsilon)}{\varepsilon + \eta(1-\theta)} = \frac{-\ln(1+\varepsilon)}{1+\phi\eta} \tag{12.18}$$

and the equilibrium level of employment across firms is

$$n = -\frac{(1-\theta)\ln(1+\varepsilon)}{\varepsilon + \eta(1-\theta)} = -\phi w \tag{12.19}$$

Both the free market level of wages and employment are below the perfectly competitive level (both expressions are negative): this is what we would expect from the textbook treatment of a single monopsonist. But, modeling interactions between firms does provide some insights that the model of a single monopsonist does not. Note that wages are always below the competitive level with the extent of the deviation depending on ε, the inverse of the elasticity of the labor supply curve to the individual employer. But, as (12.19) shows, the employment effect can be written as the wage effect multiplied by the *aggregate* labor supply elasticity. So, if aggregate labor supply is inelastic, wages will be below the competitive level but employment will not.

Now consider what happens if a minimum wage of w_m is introduced. A firm can be in one of three qualitatively distinct regimes. To understand the three regimes consider the special case where all firms face the same labor supply curve that, in the presence of a minimum wage, might be given by something like SS in figure 12.6 but they differ in the position of their MRPL curves.

In the first, which we will call the unconstrained regime, the MRPL intersects the MCL at a wage above the minimum: employment will then be on the supply curve. A firm with MRPL1 in figure 12.6 will be in the unconstrained regime. As the MRPL curve is lowered, there eventually comes a point where the wage the firm would want to pay is the minimum wage. For slightly lower MRPL curves, the firm is constrained to pay the minimum but employment will still be determined by the supply curve. Refer to these as supply-constrained firms: such a firm could be repre-

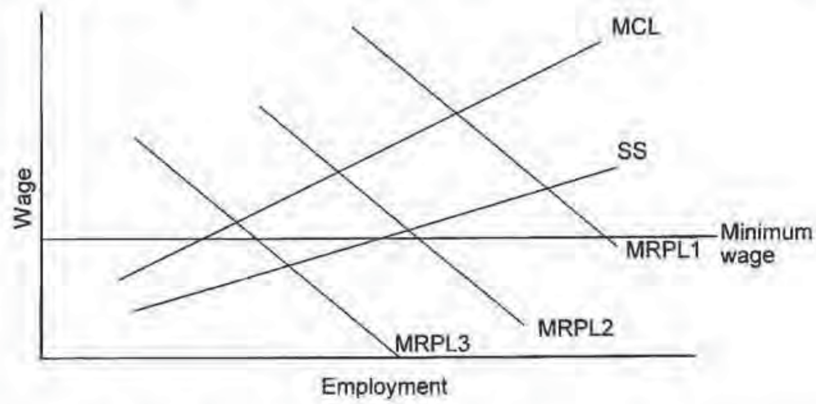

Figure 12.6 The three regimes for the impact of the minimum wage.
Notes. A firm with MRPL1 will be in the unconstrained regime as it will choose to pay a wage above the minimum as MCL and MRPL1 intersect at a level of employment requiring a wage above the minimum. A firm with MRPL2 will be in the supply constrained regime as it will choose to pay the minimum wage but employment will be on the supply curve. A firm with MRPL3 will be in the demand constrained regime as it will choose to pay the minimum wage but employment will be on the MRPL curve.

sented by MRPL2 in figure 12.6. But if the MRPL curve is lowered further still, there comes a point where the marginal revenue product of the labor supply forthcoming at the minimum wage is less than the minimum wage. These firms will be constrained to pay the minimum but employment will be at the point where the MRPL equals the minimum. Refer to these firms as demand-constrained: such a firm could be represented by MRPL3 in figure 12.6. It should be obvious from this discussion that both the supply- and demand-constrained firms actually pay the minimum wage so that there will be a mass of firms paying the minimum.

Now consider the mathematics. A firm in the unconstrained regime pays a wage above the minimum and the employment and wage rates of (12.15) and (12.16) continue to be relevant. Note that if $\theta \neq 0$, the change in w caused by the minimum wage will mean that the set of firms initially paying above w_m will not be the same as the ones now paying above w_m and that although the unconstrained firms pay above the minimum they are still affected by it (from (12.15) $n(w, a_i, b_i)$ is affected by the average level of wages). A firm will be in this regime if the desired wage as given by (12.16) is above w_m, that is, if

$$v_i \equiv \frac{\varepsilon a_i + \eta b_i}{\varepsilon + \eta} \geq w_m - \frac{\eta\theta w - \varepsilon \ln(1+\varepsilon)}{\varepsilon + \eta} \equiv v^* \qquad (12.20)$$

For a firm with v_i slightly below the right-hand side of (12.20), it is optimal to pay w_m and accept all workers forthcoming at this wage: these are the supply-constrained firms described earlier. Employment in these firms can be found by substituting $w_i = w_m$ in (12.13). One can write this as

$$n_i = \frac{w_m - \theta w - b_i}{\varepsilon} = n(w, a_i, b_i) + \frac{1}{\varepsilon}\left(w_m - \frac{\eta\theta w - \varepsilon\ln(1+\varepsilon)}{\varepsilon+\eta} - v_i\right)$$
$$= n(w, a_i, b_i) + \frac{1}{\varepsilon}(v^* - v_i) \tag{12.21}$$

where $n(w, a_i, b_i)$ is defined in (12.15). (12.21) has a simple interpretation. It says that one can think of employment in these firms as being determined by what employment would be in the absence of the minimum wage ($n(w, a, b)$) plus a measure of how much the minimum wage raises the wage in this firm above what it would otherwise be (this is $v^* - v_i$) multiplied by $(1/\varepsilon)$ which is the elasticity of employment with respect to the wage along the supply curve. Employment in these firms will be higher with the minimum wage than without.

But if the MRPL curve is sufficiently low then the firm will be in a situation where it is not profitable for the firm to employ all the workers forthcoming at w_m: these are the demand-constrained firms. They pay the minimum wage and choose employment so that $\mathrm{mrpl}_i = w_m$. Using (12.9) and (12.13), a firm will be in this regime if

$$-\frac{\eta}{\varepsilon}(w_m - \theta w - b_i) + a_i < w_m \quad \Rightarrow$$
$$v_i < w_m - \frac{\theta\eta w}{\varepsilon+\eta} \equiv v_1^* = v^* - \frac{\varepsilon\ln(1+\varepsilon)}{\varepsilon+\eta} \tag{12.22}$$

After some re-arrangement, one can derive the following expression for employment in these firms:

$$n_i = -\frac{1}{\eta}(w_m - a_i) = n(w, a_i, b_i) + \frac{\ln(1+\varepsilon)}{\varepsilon+\eta} - \frac{1}{\eta}(v_1^* - v_i) \tag{12.23}$$

(12.23) has a simple interpretation as well. It says that employment will be what it would be in the absence of the minimum wage minus a measure of the bite of the minimum wage (this is given by the term $v_1{}^* - v_i$) times the elasticity of employment with respect to the wage along the MRPL curve. Note that the second term in the final expression is the standard monopsony formula for the maximal gain in employment: this implies that firms at the edge of this region will have higher employment than in the free market.

Now, analyze the effect of a rise in the minimum wage on the market as a whole. There is no closed-form analytical solution but Appendix 12A provides the requisite mathematics. Here, we concentrate on some simulations that give a flavor of the predictions of the model. The effect of the minimum wage on employment is a function of a relatively small number of parameters: the elasticity of the labor supply curve facing a firm, $(1/\varepsilon)$, the elasticity of the MRPL curve, $(1/\eta)$, the underlying variance in the distribution of wages, σ_w, and the size of the spillover effect, θ (which also embodies the elasticity of the supply of labor to the market as a whole).

First, consider what the model implies about the relationship between the minimum wage and employment. As a base case, assume that the sensitivity of wages to employer size is given by $\varepsilon = 0.2$ so that the wage elasticity of the labor supply curve to the employer is 5. For the elasticity of the labor demand curve assume that $\eta = 1$. Finally, assume that the spillover effect is $\theta = 0.25$. For these parameter values, figure 12.7a plots the deviation in employment from the free market level as a function of the spike for a number of different values of the underlying standard deviation of log wages. For small standard deviations, the impact on employment is minuscule for all values of the spike below 10%. However, as the standard deviation rises, the employment losses become larger. The intuition is that the downside risk to employment in the worst affected firms is larger than the up-side potential in the firms where the employment impact is positive (think of labeling the horizontal axis in figure 12.4 as the difference between the minimum wage and the free market wage and then averaging across the horizontal axis to get an "average" effect on employment) so that a wider spread of outcomes leads to lower employment. If there is little dispersion in wages one can "fine-tune" the minimum wage to what is desirable for the small range of wages, whereas high underlying wage dispersion implies that a minimum wage that is good for employment in some firms will have undesirable effects for others. One implication of this is that it may be desirable to have different minimum wages for different groups of workers as, within specific groups, the variance in wages will be smaller and the minimum wage will be less of a blunt instrument.

Figure 12.7b is similar but now varies the extent of monopsony power in the hands of individual employers, ε, while fixing the standard deviation of wages in the absence of minimum wages at $\sigma_w = 0.4$. Unsurprisingly, the impact of the minimum wage is more beneficial when employers have more monopsony power. Finally, Figure 12.7c varies the spillover effect. As this rises, the minimum wages does more harm. In contrast to the textbook monopsony model, an increase in the minimum wage *always* reduces employment when $\theta = 1$ whatever the amount of monopsony power possessed by individual employers. In this case,

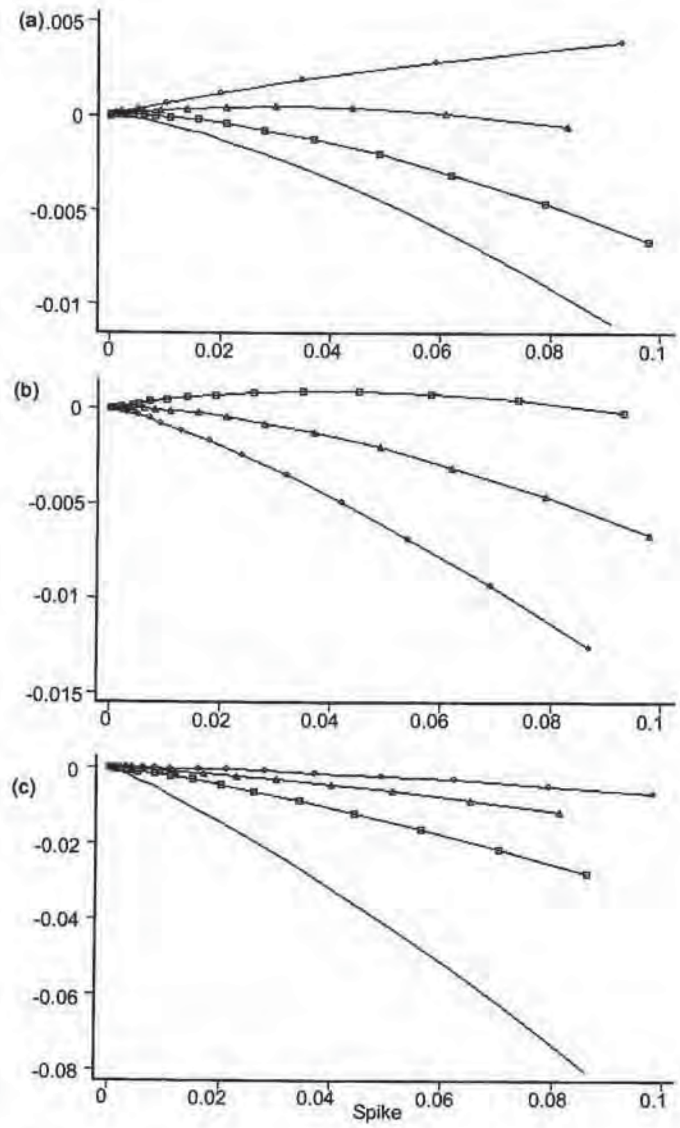

Figure 12.7 The employment impact of the minimum wage as a function of the spike. (a) The effect of varying the standard deviation of wages. ○, $\sigma_w = 0.2$; △, $\sigma_w = 0.3$; □, $\sigma_w = 0.4$; solid line, $\sigma_w = 0.5$. (b) The effect of varying the degree of monopsony power. ○, $\varepsilon = 0.1$; △, $\varepsilon = 0.2$; □, $\varepsilon = 0.3$. (c) The effect of varying the degree of spillovers. ○, $\theta = 0.25$; △, $\theta = 0.5$; □, $\theta = 0.75$; solid line, $\theta = 1$.

labor supply to the individual employer depends only on relative wages (see (12.13)) and the supply of labor to the market as a whole is completely inelastic so that a minimum wage cannot raise total employment and can only crowd out employment in demand-constrained firms.

This discussion should have made it clear that, in contrast to textbook models of single monopsonists, a low enough level of the minimum wage does not necessarily raise employment in an oligopsonistic labor market. For what they are worth (and they are a very poor substitute for empirical research), the simulations suggest that there may be a relatively wide range of minimum wages over which the impact on employment is likely to be small but that the potential down-side from excessively high minimum wages exceeds the potential up-side for a well-chosen one. However, a well-chosen minimum wage is not beyond the reach of good policy. The impact of minimum wages on employment should primarily be an empirical issue and the results of these empirical studies should be used to inform policy.

12.4 Models of Trade Unions

The textbook analysis of trade unions primarily consists of two models (for a survey, see Booth 1995). In the labor demand curve model (sometimes also called the "right-to-manage" model), unions negotiate wages with employers but employers then unilaterally choose employment given this wage. The outcome is on the labor demand curve and, the higher the union-negotiated wage, the lower employment will be. This model lies behind the common argument that unions destroy jobs.

But, an outcome on the labor demand curve is not (as long as unions care about employment at all) efficient from the perspective of unions and employers. Both agents can be made better off by some other wage–employment deal. The assumption that wages and employment are negotiated jointly and the outcome is efficient is the efficient bargain model of McDonald and Solow (1981). In contrast to the labor demand curve model, it is now possible (it depends on union preferences) that an increase in union bargaining power leads to a rise in both wages and employment—although Layard and Nickell (1990) make the point that this conclusion often does not stand up in general equilibrium.

In both of these models, labor supply to the employer is not seen as an issue: the implicit assumption is that as soon the union wage goes above the prevailing market wage, there is a potentially infinite supply of workers wanting a job in the firm. The first change to the analysis of trade unions that needs to be made when one assumes the labor market is

monopsonistic is that this is not necessarily the case: labor supply may still be a constraint even for union-negotiated wages.

Start with the simplest monopsony model in which the labor supply depends only on the wage paid by the employer, $N(w)$. In the absence of a union, the wage will be chosen to maximize profits $[Y(N) - wN]$ subject to this labor supply curve. If the employer is unionized, it is clear that the wage will rise but, in the first instance employment will still be on the labor supply curve. Note that there is no meaningful distinction here between the labor demand and efficient bargain models: given the negotiated wage, both union and employer will be happy to accept the higher labor supply to the firm. In this situation, the wage paid by the employer and employment will be positively correlated.

But, if the union negotiates a much higher wage, then the firm will enter a region where the marginal product of labor at the labor supply to the firm is less than the wage. This is a situation where the conventional analysis applies and, if the labor demand curve model is the appropriate one, then employment will begin to fall as the wage increases.

This analysis is based on the simplest monopsony model where labor supply can only be influenced by the wage paid. But, as emphasized in the overview of monopsony models in chapter 2, there are other ways in which labor supply can be influenced, for example, through the level of recruitment activity. Recognizing this might be thought to overturn the results above. For example, as wages rise and profits fall, one might think that the incentive for employers to recruit workers also falls and that this effect might dominate the direct effect on labor supply. However, the analysis of the generalized model of monopsony in section 2.3 showed that this is not necessarily the case: if there are increasing marginal costs of recruitment, employment may increase as the employer is forced to pay higher wages.

Recognizing the use of recruitment intensity as an additional instrument for influencing labor supply drives a distinction between the labor demand and efficient bargain models. One might think that it is very difficult (and relatively rare) for unions to influence recruitment intensity so that the labor demand curve model is more appropriate (in the sense of employers having unilateral control over recruitment intensity) but unions may be able to influence this by restrictions on the organization of work within the workplace (what is sometime called "feather-bedding").

This analysis of the impact of trade unions on employment should be recognized as being exactly the same as the analysis of the impact of the minimum wage. As the wage rises, employment first rises and then falls depending on whether labor supply or labor demand is the main constraint on employment. Perhaps consistent with this view is the empirical finding (see the estimates in table 4.4) that the correlation

between wages and employer size is weaker in the union than the non-union sector.

The discussion above has assumed that collective bargaining is decentralized, between an individual employer and its workers. This is the most common institutional set-up in the United States and the United Kingdom but not in many continental European countries. There collective bargaining is often at a more aggregate level: region and/or industry in many countries and even almost at the level of the whole economy in some (although the caricature of the whole economy's wages being determined in a single bargain was always some distance from reality). This type of system is often loosely described as "corporatist" although the exact meaning of the term is the subject of a debate that is best avoided in the current context.

The comparison of "corporatist" and "competitive" systems of wage determination is the subject of an extremely interesting book by Teulings and Hartog (1998). Their preferred model of the labor market is "rent-sharing" although most if not all of their conclusions would also apply if the "free" market is monopsonistic. Perhaps the most important consequence of "corporatist" wage-setting is that it reduces equilibrium wage dispersion because it attempts to mimic a competitive market and set a single wage for the whole market. Teulings and Hartog present evidence that wage dispersion is indeed lower in corporatist countries. There is little surprise in that but, more crucially, they show that this is not because the returns to skill are particularly low but because returns to variables like industry affiliation, employer size, job tenure, and gender are markedly lower in corporatist countries. They (like this book) argue that a large part of these elements of wage dispersion are the result of labor market frictions. They conclude that corporatist institutions may lead to a structure of wages that more closely resembles the ideal of a perfectly competitive market than the "free" market.

One might expect that corporatist institutions affect not just the dispersion in wages but also the level. To the extent that centralized unions are more powerful, one might expect that this will lead to higher wages. But, there are arguments that more centralized bargaining internalizes certain externalities and that this tends to lead to lower wages. This argument was first put forward by Calmfors and Driffill (1988). The monopsony model adds another possible externality to the list: when, in a decentralized system, an employer and its union negotiate a higher wage and the labor supply to a firm increases, part of this increase in labor supply is at the expense of other firms, that is, part of the private gains are the losses of other employers and unions in the economy. In contrast, a more centralized system would recognize that any increase in employment from raising wages can only come from non-employment. Hence, there are

arguments that more centralized systems of collective bargaining may lead not only to a more desirable structure of wages but also a more appropriate level. It is hard to evaluate these arguments without reference to macro-economic evidence that has many other confounding factors and, in any case, it seems slightly naive to imagine that the United States or the United Kingdom could introduce significantly greater centralization in collective bargaining. But, it is a real issue in some continental European countries.[5]

There is much theory about the impact of trade unions on employment but surprisingly little microeconometric evidence. There are a few papers that attempt to distinguish between the labor demand curve and efficient bargain models (e.g., Brown and Ashenfelter 1986; MaCurdy and Pencavel 1986) and a few papers that relate employment growth to union status (e.g., for the United States, Leonard 1992; for the United Kingdom, Blanchflower et al. 1991; Machin and Wadhwani 1991). But it is hard to find empirical papers that attempt to answer the fundamental question "what is the effect of trade unions on the level of employment?" Perhaps the main reason for this is that there are very good reasons to believe that union status is endogenous so a convincing study of the impact on employment needs a good instrument.

A recent paper by diNardo and Lee (2001) exploits the fact that, in the United States, union recognition is usually only achieved after a representation election so that there is a big difference in union status between plants in which unions get 50.1% of the votes (and gain representation) and those in which they get 49.9% and fail to get representation. However, the ex ante characteristics of these plants are likely to be very similar. Using this version of the "regression discontinuity" approach, they conclude that unions have no effect on plant closure rates and their spot estimates on the impact on employment are positive though with large standard errors. These findings are obviously hard to reconcile with the competitive view of unions but are easily consistent with the monopsony view. Undoubtedly, this is an area where more empirical research is needed.

12.5 Trade Unions and Wages

The discussion of the previous section suggests that trade unions raise wages. No surprises there, but one might be interested in whether the monopsony model has any distinctive predictions about where trade

[5] Teulings and Hartog (1998) also argue that corporatist institutions are more effective at introducing aggregate wage flexibility in response to shocks: their argument is interesting but rather far from the main subject here.

unions are more likely to make wage gains as, at least since the pioneering work of Lewis (1963), it has been recognized that the union wage mark-up varies across the economy. The economic theory of the trade union suggests that it is union preferences, union bargaining power, and the elasticity of the labor demand curve that determines the union wage mark-up. To this list, monopsony would also add the elasticity of the labor supply curve to the employer. But, it is not clear that this adds much to our understanding of the determinants of the union wage mark-up. Appendix 12B develops a simple model of the union wage mark-up and suggests that, although theory is ambiguous, it may be more likely that the mark-up will be higher in more monopsonistic labor markets. The intuition is simply that the wages set by very powerful unions will be independent of the extent of monopsony power in the labor market as labor supply will not be a binding constraint on these firms, but the wages of non-union firms will be lower the more monopsonistic is the labor market.

More interesting than the impact of monopsony on the union mark-up perhaps is the impact of union wages on wages in the non-union sector. Lewis (1963) set out the mechanisms that are widely presumed to be the ones at work. First, if union wages affect employment, then this will affect the demand for non-union labor if they are in the same product market and are substitutes or complements in production. One would expect this effect to work through the product market so it would depend on the extent of unionization in the product market. Second, if labor is displaced from the union sector, then this is presumed to increase the supply of non-union labor, driving down wages there. This effect is most likely to work through the local labor market so one might think that a measure of the local unionization rate would be appropriate for measuring this.

However, although the empirical evidence is mixed (see the original discussion in Lewis 1963, 1986; Kahn 1980; Freeman and Medoff 1981; Neumark and Wachter 1995 inter alia), it is certainly not the case that all the empirical evidence suggests that a higher rate of unionization in the local labor market depresses non-union wages. Indeed, many studies tend to reach the opposite conclusion. Following Lewis (1963), this is most commonly "explained" by the "threat effect", the idea that the greater the extent of unionization in the labor market, the higher the probability of being unionized and the greater the wage that non-union employers will be prepared to pay to avoid that possibility.

However, monopsony suggests another possibility. Non-union employers will be competing for labor with other employers including those who are unionized. The greater the extent of unionization, the higher wages are likely to be in the local labor market. What effect will

that have on the wages that non-union employers are prepared to pay? One way to answer this question is to consider what the impact on the supply of labor is likely to be. From the analysis of the determinants of reservation wages in chapter 9 (see (9.6)), one can see that a shift in the wage offer distribution will raise (reduce) the reservation wage if off-the-job search is more (less) effective than on-the-job search. The empirical evidence presented in table 9.1 strongly suggested that reservation wages will rise. In this case, non-union employers will be forced by the greater extent of unionization to raise wages to obtain the same labor supply as before. Hence, we would expect to see evidence of a positive spillover from unionization onto non-union wages. This effect can be thought of as a variant of the Harris–Todaro "wait" model of unemployment (for a discussion of this effect in the current context, see Borjas 2000: 420–21): if off-the-job search is more effective, then one has a better chance of getting one of the high-wage union jobs if one is unemployed so one's reservation wage rises.

Some empirical evidence on this is presented in table 12.3. The data set is a panel of 110 US cities from 1990 to 2000 inclusive; this is similar to the data used by Neumark and Wachter (1995) for an earlier period. The dependent variable is the log of average non-union private-sector wages. We assume the labor market is segmented by gender and by education (to maintain sample sizes we use only two education groups—those with and without more than a high-school diploma). Other controls included are the usual controls in earnings functions (gender, race, experience, and qualification) plus city and year dummies. As well as the unionization rate in the particular city–year–gender–education cell, we also include the employment/population ratio and the proportion of private-sector workers.

The results for all the segments pooled is presented in the first column of table 12.3. There is a significant positive effect of union density on non-union wages. The second and third columns then restrict attention to low and high education groups, respectively: while there is a positive effect for both groups, it is much larger for the low-education group. These results are in line with those of Neumark and Wachter (1995) for an earlier period. They are consistent with the traditional "threat effect" interpretation as well as the "wage competition effect" suggested above.

One way to try to distinguish between these two hypotheses is to see whether the impact of union density on non-union wages is larger where the threat effect might be presumed to be larger. One way of measuring the size of the threat effect is to use union density in the industry as workers in some industries are much easier to organize than others. The fourth column of table 12.3 uses as the dependent variable the average log non-union private-sector wage in industries where unionization is

TABLE 12.3
The Impact of Unionization on Non-Union Private-Sector Wages (expressed as Log Non-union Wage): Evidence from US Cities, 1990–2000

Sample	(1) *All*	(2) *Low Education*	(3) *High Education*	(4) *Low Education Industry Union Density* <5%	(5) *Low Education Industry Union Density* <10%	(6) *Low Education Industry Union Density* <20%	(7) *Low Education Industry Union Density* >20%	(8) *Low Education Eating and Drinking Places*
Union density	0.097	0.194	0.077	0.189	0.156	0.182	0.224	0.246
	(0.024)	(0.034)	(0.040)	(0.050)	(0.043)	(0.037)	(0.058)	(0.084)
Observations	5101	2463	2638	2462	2463	2463	2461	2389
R^2	0.97	0.91	0.95	0.79	0.84	0.88	0.70	0.55

Notes.
1. The individual observations are city–year–gender–education combinations where education is split into two groups: high and low. The sample is restricted to those cities with at least 10 years of observations and an average number of observations of 50 to ensure that the unionization rate does not contain too much measurement error.
2. Other controls included in the equation are the average values by cell of gender, a quadratic in experience (interacted with gender), black (interacted with gender), education, year dummies (plus a separate trend for female wages), city dummies, the male employment/population ratio, and the percentage of private sector workers in the city in the year.
3. Standard errors are clustered on city–year interaction.

below 5%. The fifth, sixth, and seventh columns then use the average for those industries where unionization is below 10%, below 20%, and above 20%, respectively. Although the wage-raising effect of unionization does seem to be largest in the high-density industries, the differences are relatively small and do not seem to be monotonic as there is a very large effect in industries where one might expect the chances of unionization to be minimal. To reinforce this point, the final column of table 12.3 presents estimates for workers in eating and drinking places where unionization is very small (2%). There is a very large positive effect of the city unionization rate on wages.

These results do suggest a positive effect of union density on non-union wages even in industries where the threat of unionization might reasonably be presumed to be minimal. However, one should be somewhat cautious in interpreting these results, particularly as it is not clear where the variation in the union density variable comes from once one has removed city and year effects: we lack a good instrument or "natural experiment" to provide reassurance on this point. But, at the very least, the "wage competition" effect should be considered to be potentially important.

12.6 Conclusions

This chapter has analyzed the likely impact of minimum wages and trade unions in labor markets where employers have market power. That both minimum wages and trade unions raise wages for workers directly affected is no big surprise. More interesting is the impact on employment and on the wages of those who are not directly affected.

The empirical literature on the employment effect of the minimum wage is enormous and no attempt has been made here to survey or contribute to it. The chapter simply provides an analytical framework for thinking about the likely effects, a framework that is important because the partial and general equilibrium effects of minimum wages on employment may be very different in monopsonistic labor markets. In contrast, the empirical literature on the impact of unions on employment is extremely small, probably because of the difficulty in treating union status as exogenous or finding good instruments for it.

The impact of minimum wages and trade unions on the wages of those not directly affected are rather different. For the minimum wage, one is looking at the impact on the wages of those paid more than the minimum and the empirical evidence for the United States suggests these effects are quite large, so large that all of the variation in wage inequality in the bottom half of the US wage distribution can be explained by variation in

the federal minimum wage. In contrast, for trade unions, the impact is on those receiving lower wages than in the union sector. The evidence presented here suggests that there are positive spillover effects of union on non-union wages, in line with the predictions of the monopsony model.

Appendix 12A

The Impact of the Minimum Wage

The following proposition outlines the relationship between the minimum wage, average wages, and employment.

Proposition 12.1

1. *The relationship between w and w_m can be written as*

$$w = w_{\mathrm{m}} + \sigma_{\mathrm{w}}\phi\left(\frac{v^*}{\sigma_{\mathrm{w}}}\right) - \left[1 - \Phi\left(\frac{v^*}{\sigma_{\mathrm{w}}}\right)\right]v^* \qquad (12.24)$$

where v^* is given by (12.20).

2. *The fraction of firms paying the minimum wage, the "spike," is given by*

$$\Phi^* = \Phi\left(\frac{v^*}{\sigma_{\mathrm{w}}}\right) \qquad (12.25)$$

3. *The derivative of w with respect to w_m can be written as*

$$\frac{\partial w}{\partial w_{\mathrm{m}}} = \frac{\Phi^*}{1 - \dfrac{\eta\theta(1-\Phi^*)}{\varepsilon + \eta}} \qquad (12.26)$$

4. *The level of employment is given by*

$$n = \frac{-\theta w - \ln(1+\varepsilon)}{\varepsilon + \eta} + \frac{1}{\varepsilon}[(\Phi^* - \Phi_1^*)v^* + \sigma_{\mathrm{w}}(\phi^* - \phi_1^*)]$$
$$+ \Phi_1^*\frac{\ln(1+\varepsilon)}{\varepsilon + \eta} - \frac{1}{\eta}(\Phi_1^* v_1^* + \sigma_{\mathrm{w}}\phi_1^*) \qquad (12.27)$$

5. *The derivative of employment with respect to w_m can be written as*

$$\frac{\partial n}{\partial w_{\mathrm{m}}} = \frac{-\theta}{\varepsilon+\eta}\frac{\partial w}{\partial w_{\mathrm{m}}}\left(1 - \Phi_1^* + \frac{\eta}{\varepsilon}(\Phi^* - \Phi_1^*)\right)$$
$$+ \left(\frac{1}{\varepsilon}(\Phi^* - \Phi_1^*) - \frac{1}{\eta}\Phi_1^*\right) \qquad (12.28)$$

Proof. The cut-off value of v_i between the unconstrained and supply constrained regimes is v^* as defined in (12.20). For unconstrained firms we have that the wage is given by (12.16) which, using (12.20), can be written as $w_i = w_{\mathrm{m}} + v_i - v^*$ while constrained firms pay the minimum wage. This immediately gives (12.25) as the fraction of firms that pay the minimum wage. For the average wage, using (12.16) and (12.17) we have

$$w = E(w_i) = \left[1 - \Phi\left(\frac{v^*}{\sigma_{\mathrm{w}}}\right)\right]E[w_{\mathrm{m}} + v_i - v^*|v_i \geq v^*] + \Phi\left(\frac{v^*}{\sigma_{\mathrm{w}}}\right)w_{\mathrm{m}} \qquad (12.29)$$

Using this in (12.29), we can derive

$$w = w_{\mathrm{m}} + (1 - \Phi^*)[E(v_i|v_i \geq v^*) - v^*] \qquad (12.30)$$

Using well-known results on the means of truncated normals (see, e.g., Maddala 1983) leads to (12.24). Differentiating (12.24) with respect to the minimum wage leads to

$$\frac{\partial w}{\partial w_{\mathrm{m}}} = 1 + \left[\frac{\partial v^*}{\partial w_{\mathrm{m}}} + \frac{\partial v^*}{\partial w}\frac{\partial w}{\partial w_{\mathrm{m}}}\right]\left[\phi^{*\prime} + \frac{v^*}{\sigma_{\mathrm{w}}}\phi^* - (1 - \Phi^*)\right] \qquad (12.31)$$

Now, for the normal distribution $z\phi'(z) = -\phi(z)$. And, from (12.20), we have that

$$\frac{\partial v^*}{\partial w_{\mathrm{m}}} = 1$$

and

$$\frac{\partial v^*}{\partial w} = -\frac{\eta\theta}{\varepsilon+\eta}$$

Using these facts in (12.31) leads to (12.26).

Employment will be an average of employment in the three regimes so using (12.15), (12.21) and (12.23), we have

$$n(w_{\mathrm{m}}) = E(n_i) = E(n(w, a_i, b_i)) + \frac{1}{\varepsilon}(\Phi^* - \Phi_1^*)E(v^* - v_i | v_1^* \leq v_i \leq v^*)$$

$$+ \frac{1}{\eta}\Phi_1^* \frac{\ln(1+\varepsilon)}{\varepsilon + \eta} - \frac{1}{\eta}\Phi_1^* E(v_1^* - v_i | v_i \leq v_1^*) \qquad (12.32)$$

where Φ_1^* is the fraction of employers in the demand-constrained regime. Using results about expectations of truncated normal variables leads to (12.27). Differentiation of (12.27) with respect to the minimum wage leads to

$$\frac{\partial n}{\partial w_{\mathrm{m}}} = -\frac{\theta}{\varepsilon + \eta}\frac{\partial w}{\partial w_{\mathrm{m}}} + \left(\frac{\partial v^*}{\partial w_{\mathrm{m}}} + \frac{\partial v^*}{\partial w}\frac{\partial w}{\partial w_{\mathrm{m}}}\right)$$

$$\times\left[\frac{1}{\varepsilon}\left([\Phi^* - \Phi_1^*] + \frac{v^*}{\sigma_{\mathrm{w}}}(\phi^* - \phi_1^*) + \phi^{*\prime} - \phi_1^{*\prime}\right)\right.$$

$$\left. + \frac{\phi_1^*}{\sigma_{\mathrm{w}}}\frac{\ln(1+\varepsilon)}{\varepsilon + \eta} - \frac{1}{\eta}\left(\Phi_1^* + \frac{\phi_1^* v_1^*}{\sigma_{\mathrm{w}}} + \phi_1^{*\prime}\right)\right]$$

After some re-arrangement, this leads to (12.28).

Discussion of Proposition 12.1

Proposition 12.1(3) shows that the effect of the minimum wage on the average wage must be positive (as long as $\theta > 0$) and less than one so that the ratio of the minimum to the average must rise as the minimum rises. If $\theta = 0$ (so there are no spillover effects), then the effect is simply Φ^* which is the fraction of firms who pay the minimum. Not surprisingly the effect is larger as the spillover effect θ increases.

Proposition 12.1(5) is surprisingly easy to understand. Consider the final term in (12.28). This says that the effect of the minimum wage on employment can be written as the proportion of firms who are supply-constrained times the elasticity of employment with respect to the wage along the supply curve minus the proportion of firms who are demand-constrained times the elasticity of employment with respect to the wage along the demand curve. If $\theta = 0$, these are the only effects but if $\theta > 0$, the rise in the general wage level reduces employment in all firms: this is the first term in (12.28).

Appendix 12B

The Union Wage Mark-Up in a Monopsony Model

A model of the union wage mark-up requires an assumption about union preferences and about the bargaining solution. Assume that union utility, V, is given by

$$\log V = \gamma \log N + \log(w - r) \tag{12.33}$$

where N is employment, w is the wage, and r is the reservation wage. (12.33) is a fairly standard specification, assuming that unions care about both employment and the surplus of wages above the reservation wage with γ giving the weight attached to employment.

Assume that wages are chosen to maximize the asymmetric Nash bargain

$$\rho \log V + \log \Pi \tag{12.34}$$

where $0 \leq \rho \leq \infty$ is a measure of union bargaining power. Assume that there are constant returns to scale so that profits can be written as

$$\log \Pi = \log(p - w) + \log N \tag{12.35}$$

where p is productivity. The assumption that there is constant returns to scale means that we are never going to be in the region where labor demand is the binding constraint: this helps to make the analysis simpler but is obviously not general.

Finally, we need to specify the labor supply curve facing the employer. Assume that we have

$$\log N = \log N_0 + \varepsilon \log(w - r) \tag{12.36}$$

Combining (12.33)–(12.36), we can write the Nash bargain of (12.34) as

$$[(1 + \rho\gamma)\varepsilon + \rho] \log(w - r) + \log(p - w) + (1 + \rho\gamma) \log N_0 \tag{12.37}$$

Taking first-order conditions of (12.37) with respect to the wage leads to the following expression for the negotiated wage:

$$w = \frac{\mu p + r}{\mu + 1} \tag{12.38}$$

where

$$\mu \equiv [(1 + \rho\gamma)\varepsilon + \rho] \tag{12.39}$$

(12.38) says that the negotiated wage will be a weighted average of marginal product and the reservation wage. The weight on the marginal product will be higher, the higher is union power (as measured by ρ) and the more competitive is the labor market (measured by ε).

But, we are interested in the impact of extent of monopsony in the labor market on the union wage mark-up. Because the mark-up is measured in the effect on log wages, this amounts to being interested in the sign of $\partial^2 \log w/\partial\varepsilon\partial\rho$. This can be written as

$$\frac{\partial^2 \log w}{\partial\varepsilon\partial\rho} = \frac{\partial^2 \log w}{\partial\mu^2}\frac{\partial\mu}{\partial\varepsilon}\frac{\partial\mu}{\partial\rho} + \frac{\partial \log w}{\partial\mu}\frac{\partial^2 \mu}{\partial\varepsilon\partial\rho} \tag{12.40}$$

Using (12.38) and (12.39), this can be written as

$$\frac{\partial^2 \log w}{\partial\varepsilon\partial\rho} = \frac{k-1}{(1+\mu)^2(1+\mu k)^2}\left\{(1-\mu^2 k)\gamma - [(1+\mu k) + k(1+\mu)]\right\} \tag{12.41}$$

where $k \equiv (p/r) \geq 1$.

The sign of (12.41) is ambiguous but is perhaps "more likely" to be negative implying that the union wage mark-up is larger in more monopsonistic labor markets. For the final term in (12.41) to be positive requires that

$$\gamma \geq \frac{(1+\mu k) + k(1+\mu)}{1-\mu^2 k} > 1 \tag{12.42}$$

so that unions have to attach more weight to employment in their utility function than wages.

13

Monopsony and the Big Picture

THE basic idea behind this book is that employers have non-negligible market power over their workers and that our understanding of labor markets would be markedly improved by an explicit recognition of this fact. In many parts of labor economics, a trend in this direction is already visible so this book has brought together existing strands of research as much as it has proposed new ones.

But, there is still some way to go before this is the conventional approach. Labor economists need to realize that, when considering the actions and decisions of a single employer, one needs to use the textbook model of monopsony rather than that of perfect competition to think about their likely behavior. One should not get too hung up on the prefix "mono': no employer exists in isolation and if one is interested in thinking about the behavior of the labor market as a whole, it is important to analyze interactions between employers and one should think in terms of a model of oligopsony or "monopsonistic competition."

13.1 The Sources of Monopsony Power

It is frictions, broadly defined, that give employers monopsony power in the labor market. The most important sources of these frictions are:

- ignorance among workers about labor market opportunities;
- individual heterogeneity in preferences over jobs;
- mobility costs.

The view that employers have some market power can hardly be controversial: it is undoubtedly true that a wage cut of a cent does not cause all existing workers to instantaneously leave the employer. But, skeptics might more legitimately wonder whether the extent of monopsony power in the labor market is large enough to justify a heavy book on the subject.

There are two ways to address these doubts. First, one can try to provide direct evidence on the extent of monopsony power. This means trying to obtain estimates of the elasticity of the labor supply curve facing individual employers. As discussed at length in chapter 4, this simple aim

is not so easy to achieve in a credible way. The estimates we have that are based on the most persuasive methodology (Staiger et al. 1999; Falch 2001) show the elasticity to be very low. But, there is scope for a lot more work here.

The second way of providing evidence on the extent of monopsony power is more indirect: to provide evidence on the predictions of monopsony and to emphasize how monopsony can provide a much better explanation of a wide range of labor market phenomena. The bulk of this book has tried to do exactly that. The market power of employers is large enough to explain, among other things, why:

- there is substantial wage dispersion in the labor market (chapter 2);
- there is an employer size wage effect (chapter 4);
- separation rates are lower for high-wage workers (chapter 4);
- employers pay higher wages to more senior workers even if productivity is no higher (chapter 5);
- more experienced displaced workers suffer larger earnings losses (chapter 6);
- part of the cross-sectional returns to job tenure is spurious (chapter 6);
- part of the gender pay gap exists (chapter 7);
- equal pay legislation does not harm the employment of women (chapter 7);
- "good" employers pay more (chapter 8);
- it is hard to find evidence of compensating wage differentials (chapter 8);
- lower-wage workers are more likely to be looking for another job (chapter 9);
- low-wage employers find it harder to fill vacancies (chapter 10);
- employers are prepared to pay for the general training of their workers (chapter 11);
- it is so hard to find evidence of job losses associated with the minimum wage (chapter 12);
- non-union employers pay higher wages in more unionized labor markets (chapter 12).

But, it is important to retain a sense of perspective on what monopsony can and cannot explain.

13.2 A Sense of Perspective

There are parts of labor economics where the conventional wisdom needs to be replaced by a new vision based on the perspective that employers have some market power over their workers. A good example would be thinking about the returns to job tenure discussed in chapter 6. But a

"global search and replace" attitude is not what is needed in most of the subject. In most parts of labor economics, the perspective of monopsony does not overwrite existing labor economics: rather it adds to it. To give a very simple example, suppose that one is trying to understand the determinants of the wage of a particular type of worker. A competitive analysis would focus on the demand curve (drawn as DD in figure 13.1) which is the marginal revenue product of labor curve and the supply curve (drawn as SS); this supply curve is the supply to the market as a whole (the elasticity of supply to an individual employer must be infinite). The level of wages is then determined by demand relative to supply. An increase in demand will raise wages, an increase in supply will reduce it.

The monopsony approach does not deny the importance of these factors or of these comparative statics. Instead, it adds another factor to the analysis: the elasticity of the labor supply curve facing the individual employer. This elasticity determines the "gap" between the supply curve and the marginal cost of labor to the employer, marked as MCL in figure 13.1. The lower is this elasticity, the lower will wages be for given demand and supply curves. One can understand this very straightforwardly if one thinks of the equation:

$$w = \frac{1}{1+\varepsilon} MPL \tag{13.1}$$

where ε is the inverse of the wage elasticity of the labor supply curve to the individual employer. It is the addition of ε that is the contribution of focusing on employer market power.

How important is the value-added of monopsony depends on the issue one is considering. If one wants to understand the gap in wages between a chief executive and the person who cleans their office then, although there are arguments in favor of the view that the labor market for cleaners is

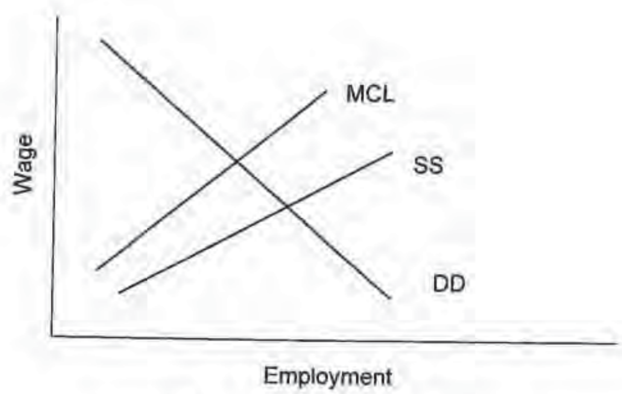

Figure 13.1 Demand and supply curves.

more monopsonistic than that for chief executives (e.g., a much higher fraction of cleaners is likely to be recruited directly from non-employment), this is not the first-order effect. Demand and supply factors are almost certainly the more important components of the explanation: it is the difference in the *MPL* part of (13.1) that is more important than the difference in the ε part in explaining the difference in wages.

But, one should not be carried away by this particular example to imagine that monopsony power is so small as to be ignorable. The frontier of labor economics is not concerned with answering easy questions like "why are chief executives paid more than cleaners?" It is about trying to answer trickier questions about the causes of changes in wage inequality, the impact of minimum wages. And, here, the impact of monopsony is of a size that labor economists cannot ignore. Few estimates of the elasticity of the labor supply curve to an individual employer exceed 5 and (13.1) then implies that wages will be 17% below marginal products, a similar order of magnitude to the union wage mark-up, the change in the log 50–10 wage differential in the United States from 1970 to 1990, and to estimates of how much minimum wages raise the earnings of the low-paid.

Virtually all of the book has been about how a market power perspective can help to explain cross-sectional regularities in labor markets. But, even if one concedes that it is helpful in that regard, one might doubt whether it is so important in explaining changes in the labor market. For example, consider the example of the chief executive and their cleaner introduced above and suppose we observe and want to explain a widening of the wage gap between them (as has occurred in the United States and the United Kingdom in the past two decades). One might explain this as the result of changes in demand relative to supply or as changes in the extent of monopsony power. It is quite likely that the former strikes most economists as the much more plausible explanation but, on closer examination, this is not so obvious.

In section 12.2, it was argued that it is the evolution of the US minimum wage that can explain essentially all of the variation in wage inequality in the bottom half of the US wage distribution in the period 1980–2000. There is no need for recourse to the currently fashionable view that it is an increase in the demand for skills out-stripping the increase in the supply of skills that is responsible. But, what has this conclusion got to do with monopsony in labor markets?

On its own, this view that the minimum wage has been the most important factor in explaining the evolution of wage inequality in the bottom half of the US wage distribution over the past 20 years need have nothing to do with monopsony in the labor market. One could believe that labor markets are perfectly competitive and still think the minimum

wage is important. The answer comes when we look at employment rates.

If one believes that labor markets are perfectly competitive, then, as the minimum wage declined in importance in the 1980s, one would expect to see rises in employment rates among those whom it affected as they were priced back into work. And, in the 1990s when the minimum wage was slightly raised, one could expect to see the employment of these groups falling. But, this is not what is observed. For example, Juhn et al. (1991) document how the employment rates of less-skilled workers fell in the 1980s (when their wages were falling fastest) and Murphy and Topel (1997) show that the employment rates stabilized in the late 1980s/early 1990s when the minimum wage was being raised. Indeed, it was exactly the observation that relative wages and employment of the least-skilled were moving in the same direction in the 1980s that led to the diagnosis of a relative demand shift as the underlying cause of the trends in employment and wages (see, e.g., the analysis in Katz and Murphy 1992). But, if the minimum wage is the cause of the changes in wage inequality in the bottom half of the distribution, then one can no longer use a perfectly competitive model to explain the changes in employment rates. In contrast, monopsony has no problem explaining the facts as there is no reason why the decline in the minimum wage in the 1980s should not have reduced the employment rates of the least-skilled.

So, the view that the labor market is fundamentally monopsonistic is necessary for understanding a "big issue"—the evolution of US wage inequality in the past two decades. Ignoring the existence of employer market power leads to incorrect conclusions on the driving force behind changes in wage inequality.

13.3 Monopsony and Labor Market Policy

One of the reasons that many labor economists feel uneasy about the use of the word "monopsony" is that it has emotive connotations that employers "exploit" workers. In the technical sense of the word, "exploitation" used by Hicks (1932) and Pigou (1924), this is true: wages are likely to be below the marginal product of labor. But, the policy conclusion that would most commonly be drawn from this fact—that wages should be raised—is not necessarily justified.

This book has been almost entirely about the positive, not the normative aspects of monopsony. This is for a good reason (described in more detail in chapter 3): one cannot draw conclusions about the merits or demerits of certain types of policy that are robust to reasonable variations in the underlying model of the labor market. The analysis of the minimum

wage in chapters 3 and 12 should have made this clear: for example, the existence of monopsony power is not sufficient for the minimum wage to be a desirable policy once one moves away from the textbook model of a simple monopsonist.

This does not mean that the book has no conclusions about labor market policy. But, the main conclusion is that one should be open-minded about the impact of policy and rely on good quality empirical research on policy before reaching any strong conclusions. The reason for this is that a monopsonistic view of the labor market does make one less inclined to a rush to judgment based on theoretical arguments. Time and again, we have seen examples where the impact of policy differs from what would be expected in a competitive labor market. The analysis of the minimum wage, trade unions, restrictions on employment contracts, equal pay legislation, and even welfare benefits may differ significantly from the conventional wisdom.

Many, if not most, labor economists have no need of the advice to be open-minded and to judge policy interventions on the basis of empirical research alone. The trend in recent years has been towards a more empirical approach and that is to be welcomed and encouraged. If this book has one thing to contribute in this area, it is to weaken still further the grip that the predictions of the competitive model has on the further recesses of the mind of some labor economists.

This instruction to be open-minded also applies to the analysis of those economies where a model of monopsony or oligopsony may not be the best way to represent the labor market. The empirical work in this book has been entirely American and British for a bad reason and a good reason. The bad reason is that it is the data with which I am most familiar but the good reason is that these are labor markets in which trade unions are weak and minimum wages and other forms of government intervention are fairly small. If one wants to look at economies that approximate "free" markets, these seem the best two to examine. However, in many continental European countries, union coverage approaches 100% and no half-decent analysis of these labor markets can ignore this fact. The analysis presented here needs, at the very least, modification. But, this does not mean this book is irrelevant as the policy debate in many of these countries is whether one should reduce regulation and "free" the labor market. Many authoritative commentators argue that European labor markets vitally need "de-regulation." When one explores the source of this recommendation one finds that it often comes from the view that the "free" labor market is well approximated by the perfectly competitive model, a view this book has challenged. If the "free" labor market is monopsonistic, this makes the alternative to European-style labor markets look less attractive and this is a factor that

needs to be in the minds of European labor economists and policymakers.

13.4 Future Directions

This book has argued that our understanding of labor markets is markedly improved by an explicit recognition of the fact that employers have some market power in the determination of wages. This claim has been made using an analysis of many of the main topics of labor economics.

Inevitably there are topics that have been omitted where the approach could usefully be applied and other topics that have been discussed which could have been investigated in more detail than is permitted in a book of this length. For example, it is likely that the literature on the assimilation of immigrants might benefit from the job search perspective which sees part of the wage growth achieved over a working life as being the result the accumulation of "search capital" rather than "human capital."

One should also recognize that there are areas where the monopsony model does not appear such a great improvement on the competitive model. I hope that I have been relatively open about where the monopsony model does not perform as well as one might hope. For example, in the analysis of compensating differentials discussed in chapter 8, monopsony offers a plausible reason for why it is often hard to find evidence of compensating differentials in cross-sectional earnings functions but the alternative approach based on estimating separations rates (while intuitively plausible) does not give a conspicuous improvement in performance.

Perhaps the most glaring omission is a good estimate of the elasticity of the labor supply curve facing an individual employer. It is this elasticity that ultimately determines the extent of monopsony power an employer has. This book has bemoaned the fact that the literature on the labor supply curve to individual employers is a huge hole in labor economics. But, while it attempts to answer this question by looking at estimates of the employer size–wage effect, or the elasticity of separations with respect to the wage, or whether there are increasing marginal costs of recruitment, one cannot help but feel that these analyses are far from perfect. The problem here is the need for good experiments: an exogenous increase in the wage paid by a single firm in the labor market. Such experiments are hard to find in the area of public policy where changes almost always affect more than a single employer. There are perhaps only two studies that even come close: Staiger et al. (1999) and Falch (2001) both concluded that labor supply to an individual employer is very inelas-

tic. But we have little idea of how robust this conclusion is to other labor markets.

13.5 Conclusions

This book opened with a thought experiment: what happens if employers cut wages by a small amount? If one is tempted to doubt the relevance of believing that employers have some market power over their workers, just remember that the alternative is to believe that the workers leave so fast that the door does not stop revolving. It is just so much more plausible and reasonable to think that employers do have meaningful discretion over the wages they choose to pay. Labor economists will find that the labor market is so much less puzzling once they recognize that fact and, hopefully, they will be able to sleep more easily in their beds as a result.[1]

[1] Though anyone who has got far enough to read this sentence may have a lot of trouble in getting to sleep in any circumstance.

Data Sets Appendix

A CONSIDERABLE number of data sets are used in this book and there would be needless duplication if the way in which the data was constructed was discussed each time a data set was used.

The way in which the key variables in the main data sets were constructed is described here. All "do-files" used to run jobs are available on request and, where licensing agreements allow, copies of the data sets used are also available.

United States

The Current Population Survey

The CPS has a rolling panel structure in which sample individuals are interviewed monthly for four months, then retired for four months and then interviewed monthly for a further four months. Details about the CPS can be found at http://www.bls.census.gov/cps/cpsmain.htm. The NBER also has very useful information at http://www.nber.org/data/cps_index.html.

EDUCATIONAL ATTAINMENT

Those with completed education less than 12th grade or no diploma (PEEDUCA $\leq$ 38) are classed as high-school drop-outs, those with high school diploma or equivalent (PEEDUCA = 39) as high-school graduates, those with some college but less than a bachelor's degree (40 $\leq$ PEEDUCA $\leq$ 42) are classed as some college, and those with a bachelor's degree or higher (43 $\leq$ PEEDUCA) as college graduates.

EXPERIENCE

Experience (really potential experience) is computed as age minus 17 if PEEDUCA $\leq$ 36, age minus 18 if 37 $\leq$ PEEDUCA $\leq$ 39, age minus 19 if PEEDUCA = 40, age minus 20 if PEEDUCA = 41 or 42, age minus 22 if PEEDUCA = 43, and age minus 24 if PEEDUCA > 43. Experience is set to zero for all those still in full-time education.

WAGES

Earnings information is only recorded for those in the outgoing rotation groups (MIS = 4 or MIS = 8). For those who are paid by the hour, the

reported straight-time hourly wage in PTERNHLY is used. For those who are not paid by the hour, the hourly wage is computed as weekly earnings, PTERNWA, divided by weekly hours, PEERNHRO. Those with hourly earnings below \$1 and above \$100 per hour are dropped.

ETHNICITY

An individual is coded as black if they answer "black" in the question PERACE. In addition, individuals are classed as Hispanic if they are recorded in PRORIGIN as being of Hispanic descent.

MARITAL STATUS

Marital status is derived from the variable PEMARITL. Those who record that they are currently married but with an absent spouse are treated as married.

CHILDREN

The number of dependent children in the household is computed by counting the number of individuals aged less than 18 in the household and the age of the youngest child is computed as the youngest of these individuals.

ECONOMIC ACTIVITY

This is derived from the variable PEMLR. Job changers are identified from the question PUIODP1.

The Panel Study of Income Dynamics

The PSID is a longitudinal survey of a representative sample of US individuals and their families. It started in 1968 and information was collected annually until 1997. More information can be found at http://www.isr.umich.edu/src/psid/.

EDUCATIONAL ATTAINMENT

For each individual, the maximum level of years of completed education reported is used as the basic measure of educational attainment. This is then converted to four dummy variables corresponding to:

high-school drop-out	11 or fewer years of education completed
high-school graduate	12 years of education completed
high-school graduate	13–15 years of education completed
college graduate	16+ years of education completed.

EXPERIENCE

This is computed as age minus years of completed education minus 6. Those for whom experience is negative are dropped from the sample.

JOB TENURE

First, each job observed at an interview date is labeled as a new job (NEWJOB = 1) or an old job (as compared to the previous interview date) (NEWJOB = 0). A number of rules are followed:

- if the respondent was not in employment at the previous interview, the current job is a new job;
- if the respondent was in employment at the previous interview, the current job is a new job if the recorded start date for the job is before the date of previous interview.

This leaves open the elapsed job tenure of the job held at the first wave for which the individual is observed. The recorded start date for the job is used to measure this.

Job tenure is now computed as follows. If NEWJOB = 0, tenure is previous tenure plus 1. If NEWJOB = 1, tenure is set to zero. This procedure leads to missing values for job tenure for all waves where NEWJOB is missing at some previous point in that job spell. The procedure ensures that measures of job tenure are internally consistent as recommended by Brown and Light (1992).

For those in new jobs, we are also interested in whether they have been in continuous employment or whether they have had a spell of non-employment. Individuals are recorded as having had a spell of non-employment if either of the following conditions is satisfied:

- if the respondent was not in employment at the previous interview;
- a period of non-employment (either unemployment or inactivity) lasting longer than a week is recorded between the two interview dates.

WAGES

The PSID only asks about wages for heads of household and their spouse. On the main job, workers are asked whether they are salaried, paid by the

hour or some form of performance-related pay (commission, tips or other). The sample is restricted to those who report being salaried or just paid by the hour. In 1994, this is about 85% of those responding to the question. The main excluded group (about 12%) are the "other" pay system for whom it is hard to work out an hourly wage.

The salaried workers are asked to report their salary and the pay period to which it refers. Assuming they work 40 hours per week (there is no more precise information on hours worked), this is then converted to an hourly wage. The hourly paid workers are asked about their hourly wage for their regular work time.

ETHNICITY

Individuals are divided into one of two groups: white or non-white.

MARTIAL STATUS AND CHILDREN

The individual is recorded as married if a spouse is recorded as living at the same address. The presence of dependent children comes from a direct question.

WEIGHTS

Only the core sample is used and the individual weights are used for this sample.

The National Longitudinal Study of Youth, 1979

The NLSY79 is a nationally representative sample of 12,686 young US men and women who were 14–22 years old when they were first surveyed in 1979. These individuals were interviewed annually through 1994 and are currently being interviewed on a biennial basis. More information can be found at http://www.bls.gov/nls/nlsy79.htm.

EDUCATIONAL ATTAINMENT

For each individual, the maximum level of years of completed education reported at any interview before they are recorded as having left education is used as the basic measure of educational attainment. This is then converted to four dummy variables corresponding to:

high-school drop-out	11 or fewer years of education completed
high-school graduate	12 years of education completed
high-school graduate	13–15 years of education completed
college graduate	16+ years of education completed.

EXPERIENCE

The year in which the individual left full-time education is recorded as the latest year in which the respondent reported currently attending or being enrolled in school. In the first year after this, experience is given the value zero and then augments by one each year.

CURRENT JOB

Individuals are asked whether they are in employment in the week of interview. If they are in more than one job, one of them is identified as the CPS job (the one in which they worked the most hours). The details of this job are recorded for wages.

EMPLOYMENT RECORD

From the work history file a series of derived variables recording number of weeks between interviews in employment, unemployment out of the labor force, in military service or unaccounted for. From this we define those as being in continuous employment if all weeks are in employment or the military.

JOB TENURE

First, each job observed at an interview date is labeled as a new job (NEWJOB = 1) or an old job (as compared to the previous interview date) (NEWJOB = 0). A number of rules are followed:

- if the respondent was not in employment at the previous interview, the current job is a new job;
- if the respondent was in employment at the previous interview, the current job is a new job if any break in employment is recorded or the number of employers since the last interview is bigger than one.

Job tenure is now computed as follows. If NEWJOB = 0, tenure is previous tenure plus 1. If NEWJOB = 1, tenure is set to zero. This procedure leads to missing values for job tenure for all waves where NEWJOB is missing at some previous point in that job spell.

WAGES

The hourly wage on the CPS job is used. Those with hourly wages less than a dollar or more than 100 dollars are excluded.

ETHNICITY

Individuals are divided into one of two groups: white or non-white.

MARTIAL STATUS AND CHILDREN

The individual is recorded as married if a spouse is recorded as being present or that they currently live with a partner. The presence and age of own children in the household comes from a direct question.

United Kingdom

The Labour Force Survey

The LFS is the UK equivalent of the CPS. Since the inception of the quarterly panel in 1992, individuals are interviewed for five successive quarters. More information can be found at http://www.data-archive.ac.uk/findingData/lfsAbstract.asp.

EXPERIENCE

Experience (really potential experience) is computed as age minus age last left full-time education. Data on age left full-time education come from the variable EDAGE.

EDUCATIONAL ATTAINMENT

The LFS classification of educational attainment has been changed twice since the introduction of the quarterly survey in the Spring of 1992. Currently, the relevant variable is HIQUAL: prior to Spring 1996 it was HIQUAP. HIQUAL currently has 40 different levels of educational attainment: these are combined into four categories as follows:

college degree	$1 \leq$ HIQUAP ≤ 12
"A" level or equivalent	$13 \leq$ HIQUAP ≤ 24
GCSE or equivalent	$25 \leq$ HIQUAP ≤ 37
no formal education qualification	HIQUAP = 38 or 40.

Those with HIQUAP = 39 (other educational qualification) are coded as missing as no indication of the level is given.

JOB TENURE

The LFS asks questions about the year the individual started work for the current employer (CONMPY) and, where this is less than 8 years ago, the month (CONMON). Tenure is then computed as the difference in months between the date of interview and the starting month. Where CONMON is not recorded it is assumed to be July.

WAGES

Earnings information is only recorded from Winter 1992 and then only for those in wave 5 (i.e., about to leave the sample) until Spring 1997 when earnings information is also collected for those in wave 1. Gross weekly pay in main job is recorded in GRSSWK. This converted to an hourly wage by dividing by the sum of total usual hours worked in main job (BUSHR) and usual hours of paid overtime (POTHR). Those with hourly wages below £1/hour or above £100/hour were excluded from the sample.

ETHNICITY

The LFS records information on twelve ethnic groups. For analysis, we combine these into three categories:

white	white, other-other, and other-mixed ethnic group (the last two groups being very small)
black	black-Caribbean, black-African, black-other (non-mixed), and black-mixed
Asian	Indian, Pakistani, Bangladeshi, Chinese, and other-Asian (non-mixed).

MARITAL STATUS

Marital status is derived from the variables MARSTT and LIVTOG. Those who record either that they are married and living with spouse or that they are living together as a couple are recorded as married: all others are regarded as non-married.

CHILDREN

The number of dependent children in the household is taken from HDPCH19 and the age of the youngest child comes from AYHL19.

ECONOMIC ACTIVITY

This is derived from the variable INECACA.

The British Household Panel Study

The BHPS is approximately the British equivalent to the PSID. It started in 1991 with some 5500 households and 10,300 individuals drawn from 250 different areas of Great Britain and has subsequently followed these individuals and others who may have ended up in a household with them.

More details can be found at http://www.iser.essex.ac.uk/bhps/index.php.

EXPERIENCE

Experience (really potential experience) is computed as age minus age last left full-time education. There are two sources of information on age last left full-time education. First, there are direct questions (SCEND and FEEND) about the age at which the respondent last left full-time education. Second, individuals may record that their current economic activity (JBSTAT) is full-time education. If this is the case, we record the last age at which this is reported as age left full-time education. We then use the maximum of these two measures as our composite measure of age left full-time education. Experience is constructed so that it augments by one year each wave by taking the lowest level of experience observed as the base.

EDUCATIONAL ATTAINMENT

The BHPS defines twelve levels of highest educational qualification (QFEDHI). These are then combined into four categories:

college education or equivalent	higher degree, first degree, teaching qualification and nursing qualification
"A" level or equivalent (left school at 18)	other higher qualification, "A" levels, apprenticeship
GCSE or equivalent (left school at 16)	"O" levels, commercial qualification, CSEs, other qualification
no qualification	no qualification.

JOB TENURE

The BHPS has the complication that the basic information on job tenure relates to the length of the spell in a single job, and not with a single employer, so that, for example, a promotion within a firm sets the tenure

clock back to zero. For comparability with other data sets, it is helpful to have a measure of tenure with a single employer. This is computed in the following way.

First, each job observed at an interview date is labeled as a new job (NEWJOB = 1) or an old job (as compared to the previous interview date) (NEWJOB = 0). A number of rules are followed:

- if the respondent was not in employment at the previous interview, the current job is a new job;
- if the respondent was in full-time education at the previous interview, the current job is a new job;
- if the respondent was in employment at the previous interview, the current job is a new job if the job history file records a change in employer between the two interview dates.

This label fails to exist when there was no interview in the preceding wave or the job history information is missing from the current wave. For wave 1, we use information on the job held at September 1, 1990, to ascertain whether it is new or not.

This leaves open the elapsed job tenure of the job held at September 1, 1990. Information from the life history files are used to derive this.

Job tenure is now computed as follows. If NEWJOB = 0, tenure is previous tenure plus 1. If NEWJOB = 1, tenure is set to zero.

This procedure leads to missing values for job tenure for all waves where NEWJOB is missing at some previous point in that job spell. And, it leads to missing values wherever it is impossible to assign job tenure to the job held at September 1, 1990. The procedure does lead to an under-estimate of average job tenure but we are solely interested in being able to condition on it.

We are also interested in employment status before starting a new job. For all new jobs, we try to use the job history file (where available) to work out employment status in the spell immediately preceding starting to work for the current employer. For those workers with zero experience, we automatically assume that they were previously in non-employment.

WAGES

Hourly earnings are computed by taking usual monthly gross pay in the current job (PAYGU), dividing by number of hours per week usually worked (JBHRS + JBOT) and then multiplying by (30/7). Those observations for whom PAYGU was imputed or a proxy response are removed from the sample. Those for whom the computed hourly wage was less than £1 per hour or greater than £100 per hour were removed from the

sample. In contrast to the PSID, the BHPS records earnings information for all household members in employment.

ETHNICITY

The BHPS records information on ten ethnic groups in RACE. For analysis, we combine these into three categories:

white	white and other ethnic group (the latter group being very small)
black	black-Caribbean, black-African, and black-other
Asian	Indian, Pakistani, Bangladeshi, and Chinese.

MARITAL STATUS AND CHILDREN

Marital status is taken from the variables MASTAT. Those recorded as married or living as a couple are classed as married. The number of children is the number of children in the household (NKIDS).

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